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Construction Kinks

ANOTHER low-head hydroelectric station using large single-runner Francis turbines is under way on the Mississippi River. Unlike Keokuk, with its ideal, practically level foundation of limestone, the Coon Rapids plant above Minneapolis, described on page 77, is built on piles driven through various thicknesses of glacial drift to impervious clay, hardpan or a cemented gravel. This condition brought about numerous problems, not the least of which were the excavation difficulties encountered under the power house. Driving piles through the ice and getting the drivers off just in time to see the support float away are escapes contractors like to recount. Little danger, however, existed from occupying positions on 5 to 7 ft. of ice, and toward spring the drivers, as a safety measure, were usually located on piles. New methods of form-building never seem to be exhausted. At Coon Rapids steel ribs, used for the curved spillway section, were turned over and utilized for the straight portions of the retaining dam. When the openings left in the spillway section to pass the water during the construction period are closed the vertical ribs will carry stop-log grooves for the closing cofferdam. With the ever-increasing price of lumber and the enormous quantities used in building draft-tube and scroll-case forms it is commendable that the forms in this development were made collapsible. So easily were they put together after once being erected that two days' time only was required for re-erection.

No Relief for Errors in Bid

COURT aid was invoked without success in New York recently in order to allow a contractor to amend clerical errors claimed to have been made in his bid. The plea was that if the correct figures had been used the bid would have been the lowest, and the aggrieved contractor asked for an injunction to restrain the Public Service Commission from awarding the contract to another bidder until his bid could be amended and considered. The procedure was a most extraordinary one, and the court, very properly, it seems to the Engineering Record, denied the petition for an injunction. The abuses of such a court precedent, if established, can readily be imagined. A brief extract will show that the court fully appreciated the possible mischief. In his decision, the judge said: "I am of the opinion that the granting of the application would establish a precedent which would enable a future bidder on a contract for public work to deliberately specify what would seem unusually large prices for certain items, with the idea that if with those items he turned out to be the lowest bidder he would take the contract, while if he was the second lowest bidder he would claim that a mistake had been made and demand the right to correct his bid so as to make him the lowest bidder. In the absence of fraud the court cannot substitute itself for the Public Service Commission, which has full power under the statute to act in the awarding of contracts. Public interest requires that bidders be held to their bids in order that delays may be obviated or minimized in the prosecution of public improvements."

Short Highway Courses

AN illustration of the possibility of utilizing the extension system of education for other than purely cultural purposes is afforded by the short courses in highway engineering which are to be given soon in several colleges and universities in the East and the Middle West. The scheme combines lectures and field demonstrations during a period of two weeks in January or February and is designed to bring engineers, contractors, inspectors and highway officials to a clearer conception of the needs of present-day roadmaking. As the brief instruction can merely direct the student's energies in the right path, it will be largely rudimentary, but its need is almost in inverse proportion to its elementary character. What is to be especially noted is the whole-hearted co-operation between the State highway authorities and the colleges. The course at the University of Illinois, intended especially to equip prospective county-road superintendents for service under the new road law, is typical of the courses announced by other schools. The engineering faculty of the university and the staff of the State highway engineer are to combine in carrying out the schedule. An effort is to be made to impart instruction in a manner which, while carrying proper knowledge of detail, will hold the interest of the student, and to this end periods for discussion are wisely made a feature of the plan. In all the colleges the courses have been as widely advertised as the resources have permitted, and no tuition will be charged. The scheme has such merit that it is quite safe to predict that it will spread to many institutions besides those which have now adopted it, and that for those who have the leisure more advanced courses will ultimately be arranged.

Isolation of Transformers

THE burning on Dec. 11 of the Portman Shoals hydroelectric development on the Seneca River, 10 miles from Anderson, S. C., was mentioned in a short note in the Current News Section of this journal on Dec. 20. The output of the plant was 5500 hp, and the accident has seriously crippled cities and factories depending upon the station for power. The generator of a runaway unit burst and a flying piece struck and ignited a transformer. The burning oil spread quickly to all parts of the generator room, threatening the lives of the operators, one of whom, saturated with flaming oil, jumped into the icy waters of the stream to save himself. Another operator was struck by a flying piece of the generator and was seriously hurt. Three others escaped without injury. There were in the plant five units, two of which are damaged, due to the runaway and at least two others due to the burning oil. This, of course, is not the first disaster of the kind. It is pertinent, therefore, that wrongful conditions be pointed out. If the generator did not have sufficient strength, according to the design, to stand the runaway speed during a time sufficient to stop the unit, the manufacturer was at fault. If the bursting, however, was due to defects in the material, it might be difficult to say whether any blame attached. For the conflagration, however, responsibility would seem clearly to rest with the designer, who failed to separate the hydraulic equipment from the electrical and did not provide adequate means for draining the burning oil. It cannot be too strongly emphasized that transformers should be placed in fireproof compartments, and that each compartment should have large sumps and drain pipes, so that the burning oil can be quickly discharged into the stream below.

World's Longest Tunnel

IN its journey toward completion the Catskill Aqueduct passed another milestone on Jan. 12, when the last pair of tunnel headings on the 110 miles of line from the Ashokan reservoir to the terminal shafts in Brooklyn were holed through. But the meeting of the two bores is significant from another viewpoint. It signalizes the opening of the longest stretch of continuous tunnel in the world. The clear length from end to end of this pressure-tunnel portion of the great conduit is 18 miles, or 6 miles longer than the Simplon, the holder of the former record for length. Just before he closed the switch which fired the last blast, the Hon. John Purroy Mitchel, New York's new mayor, said some very complimentary things about the engineers and contractors to whom the city is indebted for the rapid and efficient prosecution of the work on the new water-supply system. That this praise was well earned is apparent to anyone who has visited the great Ashokan and Kensico dams, descended 1100 ft. into the gigantic siphon tube, which plunges under the Hudson River, or walked through mile after mile of the cut and cover aqueduct and steel pipe. As a result of Monday's blast there is an unobstructed opening for the free flow of water from one end of the aqueduct to the other, and the danger of a water famine, such as threatened the city a few years ago, is now definitely removed. In an emergency Catskill water could be delivered to New York at very short notice. Now that the waterway opening is cleared the work remaining is the completion of the tunnel linings and the installation of the regulating works at the shafts. Thus the aqueduct has developed, in a few years, from an irregular black line on a sheet of tracing paper to a hundred-mile tube of concrete and steel. In reality engineers do more amazing feats than the Hindoo magicians who make mango trees grow before one's eyes.

Uniformity in Road Laws

ANY one who has endeavored to carry in mind the main features of the highway laws, even in the States where satisfactory statutes exist, will realize that a large and much-needed task lies before those members of the American Highway Association and of the American Bar Association who are working on a joint committee to secure uniformity in highway legislation. While uniformity for uniformity's sake might have some justification, the chief advantage will come in having the best practice receive wide acceptance and written into the less satisfactory laws.

The plan of the committee is to obtain the assistance of the Office of Public Roads and of all State highway departments in a compilation of all laws on the subject of roads. It is not the intention to make a digest of this legislation. The statutes of the different States will be recorded in their entirety and when the compilation is completed the Governors of the various States will be asked to request the Legislature to appoint committees to meet with the officials of the highway and bar associations. The committee has, however, laid down certain basic principles which will be recommended for enactment by all the States. Among these are the establishment of non-partisan boards, which will select all engineers in direct charge of roads with a view to excluding the chief road officials from politics, and the selection of road chiefs for periods determined only by their usefulness.

While the use of the material which will thus be made available to the Legislature may not always be the best, it is morally certain that the work will have a large and beneficial influence. The two associations are to be congratulated on their courage in entering upon the work. That it may be crowned with success beyond present expectations is the wish of all students of the highways problem.

Should Railroad Grade Crossings Always Be Avoided?

"SHOULD railroad grade crossings always be avoided?" is a question raised by Mr. L. W. Duffee on page 85. He points out that frequently in the case of small railroads built chiefly for freight, elevation above or depression below existing lines means disproportionate cost of construction and awkwardness in reaching industries alongside. He therefore concludes that in such a case grade crossings would be justified.

The Engineering Record ventures no opinion as to the merits of the particular case he cites. When extension of yards would serve to shut out a competitor, railroad managements are not above dreaming of large additions to take care of expected increases in business. That the existing roads at Meridian, Miss., were willing to pay for the bridges over their property would indicate that their plans for expansion were genuine. If so, their yards of the future would have been cut in two by the new line, and the inefficiency of operation of fragmental yards in congested urban districts has been so clearly demonstrated that there was ample justification for the fight offered by the existing roads at Meridian against the proposal of the new line.

Naturally the density of traffic upon the proposed and the existing lines would be a considerable factor in settling the matter. If the traffic on all were sparse the case would be the more favorable to the grade-crossing plan.

It is probably true that the grade crossings proposed at Meridian would, if constructed, have been far less dangerous than many now in existence. As a general proposition, however, the railroad grade crossing is doomed and the construction of new ones should be discouraged. The crossing is bound to be an element of danger, and at those protected only by signals chances are taken every day, resulting now and then in accidents. Where there are derails, freight trains frequently run through them, overturning engines and killing crews. When the crossing is flanked by yard tracks and buildings the view is obscured and the danger increased.

The difference in attitude toward grade crossings in level and rough country is worth noting. In the Middle West a high embankment is considered a waste of money and grade crossings are abundant even at points of heavy traffic. In the East, however, where heavy grading is accepted as an incident of railroad building, large sums are spent even to keep conflicting streams of traffic on the same road from crossing each other at junction points. The avoidance of grade crossings is not such a tremendous undertaking where there is a proper spirit of compromise, so that as one road is raised the other is depressed. Short, steep momentum grades, too, are not highly objectionable. Industries, moreover, can usually be reached by elevated tracks on trestles or by low-level auxiliary tracks alongside the embankment. The objection offered to elevated tracks on account of the danger of derailment would have little standing in a comparison of the alternate plans.

While, as above stated, the data at hand are not sufficient to say the final word as to the merits of the situation at Meridian, Miss., there need be no hesitancy in laying down as a fundamental proposition that grade crossings are undesirable and that plans in general should proceed on the basis that they should be avoided.

Climatological Year as Basis for Water Reports

IN the compilation of Water Supply Paper 300, entitled "Water Resources of California," the United States Geological Survey has departed from the long-established custom of compiling its discharge tables on the basis of the calendar year by substituting a climatological year extending from Oct. 1 of a calendar year to Sept. 30 of the succeeding calendar year. It is understood that it is now the purpose of the Water Resources Branch of the Survey to publish data on this same basis for all the drainage basins lying to the west of the Rocky Mountains. This change is being made to facilitate the work of the Water Resources Branch itself in compiling the data and to make the publications of the Survey more convenient and useful to the public.

Throughout a large portion of this area the calendar year terminates in the middle of what is called the ice period of the rivers, making it necessary to compute the runoff at the end of the calendar year for the first part of the ice period without full information for the whole period. Such procedure necessarily results in difficult and inaccurate assumptions for the incompleted ice period. The use of a climatological year obviates this difficulty and brings the entire period within one table.

By subdividing the United States into an eastern and western region and using the calendar year for the eastern division and the climatological year for the western the work of compiling stream-flow data for publication is spread over a longer period, thereby equalizing the work and increasing the output of the employees of the Water Resources Branch. At the same time this plan insures more permanent employment of the office men and, therefore, better results, with more prompt publication of the data, which will be of advantage to those who use the publications.

State engineers and other State officials who find occasion to incorporate in their annual reports data on stream flow in their States will be able to obtain the final compilations of the work of the Water Resources Branch in time to use them for this purpose. This will, of course, be of advantage to those interested in the State reports.

The termination of the climatological year chosen for the basis of compiling stream-flow data corresponds quite closely to the closing of the agricultural year throughout the arid regions. There is also quite a marked decrease in the aridity of the climate west of the Rocky Mountains shortly after Oct. 1; and the runoff during the months of October, November and December becomes, where storage reservoirs are employed, available for irrigation in the succeeding calendar year. For this reason stream-flow data compiled on such a year will be in acceptable shape for irrigation engineers in making studies of storage and of normal-flow conditions of rivers.

The proposed change, therefore, from the calendar year to the climatological year is one of considerable importance not only to the Geological Survey itself but to the public generally. It has so many advantages when applied to the arid regions that the plan is to be heartily commended.

Conservation in Engineering Education

THE announcement that the engineering departments of Harvard University and the Massachusetts Institute of Technology are to be combined under a single administration will be welcome news to all friends of educational conservation. While the formal agreement between the authorities was reached last week, the success of these negotiations was forecast when President Maclaurin outlined the benefits of the proposed co-operation in the latter part of 1912. Comment upon the advantages of the plan was printed in the Engineering Record of Dec. 28, 1912, and the passage of time has merely strengthened the conviction that the program now adopted will greatly increase the efficiency with which the engineering resources of the two institutions will be utilized.

The first principle in the agreement is that each institution is to remain entirely unaffected in name, organization, property rights and in all other ways not specifically mentioned, each having control of its own financial resources and being free to lay down such regulations with respect to the courses leading to its own degrees as it sees fit. The co-operation is limited to the fields of mechanical, electrical, civil, sanitary and mining engineering, all of which require large investments in laboratories and equipment and considerable expense in their maintenance. In the interests of efficiency, convenience, the concentration of effort and the elimination of waste it is agreed that all the work of education and research in these branches of applied science shall be carried on within the buildings of the Institute now being erected on its new site in Cambridge. For the maintenance and equipment of these laboratories and the payment of salaries, the University agrees to set aside practically all the funds that it would otherwise be free to devote to these branches. The Institute will devote for the same general purpose all the funds that it now holds for work in these departments. Both institutions also agree that their respective measures of support may be increased if disposable funds are available. The moneys allotted will be expended and the work conducted under the direction of the president of the Institute, an annual report being made to both corporations. Harvard will also have a voice in the selection of succeeding presidents of the Institute.

The technical faculty will be enlarged by the addition of professors, assistant and associate professors from the engineering departments of one institution to those of the other, so that these instructing officers will have the same titles and rank in the University that they hold in the Institute, and vice versa. The enlarged faculty will lay down the engineering courses under the regulations of each institution, and unless the regulations are different, the courses leading to the same degrees will probably be identical. Temporary arrangements will be made by which some of the benefits of the agreement may be realized prior to the completion of the Institute's new plant.

The further working out of the agreement will be followed with much interest by engineers. No extended comment is needed to demonstrate the economic possibilities of such an arrangement, since the "load-factor" of institutional laboratories and equipment is notoriously low on account of the small proportion of time that the apparatus units are in actual service. President Lowell of Harvard well says that "both institutions will gain by the arrangement; that which gains the more probably cannot be determined, and certainly has not been computed; for the leading motive of the authors of the agreement has lain in another plane. Both institutions exist for the promotion of instruction and research. Each is a means to an end larger than itself—the welfare of the community as a whole. That both acting in concert can further this end better than either working alone cannot be doubted. By the combination of resources and momentum a school ought to be maintained unequalled on this continent, and, perhaps, in the old world."

The engineering professions may well applaud conservation of this sort, which adds so much to the efficiency with which existing and forthcoming facilities can be used and which points the way toward a centralization of effort in the direction of research which cannot but redound to the welfare of society.

Ford's Profit-Sharing Plan

IT was to be expected that the announcement by Henry Ford, the Detroit automobile manufacturer, of his plan by which $10,000,000 of profits will be distributed to his employees and a minimum wage of $5 a day established would cause a considerable disturbance in the labor market at Detroit and much comment in the newspapers and among the people at large. The total sum involved is not only very large, but the minimum wage so far exceeds present minima in the same and similar industries that inquiry as to its effect is necessary on the part of all industrial managers.

From the standpoint of profit-sharing the plan has been generally indorsed. Controversy has raged principally about the advisability of so high a minimum wage. As to this, the general proposition may be laid down that any wage in excess of what employees reasonably should earn, judged by the standards of the day, cannot permanently endure, simply because human nature, even in an organization like Mr. Ford's, will inevitably demand full value for what is given. In other words, the tendency in the Ford plant will inevitably be to eliminate all employees who are not of five-dollar grade. That is already foreshadowed in the announcement of the Ford company that men who are not giving satisfactory service in one department will be shifted to another, and again to another, until work for which they are adaptable has been found. There is no need to emphasize the fact that there are many who, measured by present-day standards, will not in any department fully earn a five-dollar wage. It is likely, then, that the Ford company, eventually, is not apt to be the loser by setting so high a wage. The efficiency of its employees will unquestionably increase, the ésprit de corps will be unrivaled and will insure the perpetuation of the organization.

From the standpoint of other employers, particularly in the same industry, the move is apt to be very disturbing for a long time. It is difficult to see how labor troubles in the Detroit district will be avoided during the next few years, for the factory workers to a man will be seeking to rise to the Ford level.

That the plan has been well thought out, in some respects at least, is patent to those familiar with efforts to increase the efficiency of men and who have studied profit-sharing plans. Profit sharing, as the term is generally understood—namely, a division of profits among employees at the end of the year—is a doubtful method of increasing efficiency and bringing about satisfactory industrial conditions. Under that plan all men in the same grade are rewarded alike. The fact that one may be efficient and the other inefficient makes no difference in their share in the profits. Moreover, the holding out of the prospect of profit-sharing at the end of the year is not a sufficient incentive to efficiency. The reward is too far removed.

It is for these reasons that many firms have decided against profit-sharing plans and instead have adopted a bonus system. This has advantages at just the points where the profit-sharing system is weak. It rewards men solely upon their performances, and two men in the same grade, one efficient and one inefficient, do not receive the same compensation, as under the ordinary profit-sharing scheme. Moreover, the men find their reward in their pay envelopes every week, and each bonus offers an incentive to maintain production at the same rate or increase it, if the man is not working up to a reasonable output, taking into consideration physical limitations.

Mr. Ford undoubtedly has recognized the drawbacks, but nevertheless has chosen a profit-sharing rather than a bonus scheme. He sees, however, that an award held out a year hence is an unsatisfactory incentive, and his distribution will, therefore, be made at intervals of two weeks.

The thoughts here advanced are well worth while bearing in mind in studying the distribution of wealth created in industry to those who have had a share in producing it. Unless the increase makes for contentment, ésprit de corps and higher efficiency it has not been well spent. It is safe to say that Mr. Ford's plan, as far as his own organization is concerned, is an excellent move. The only reason to question it is as to its effect upon other industries in Detroit. Its operation, in this respect, will naturally be closely watched.

Jordan River Dam on Vancouver Island

Hollow Reinforced-Concrete Structure, 126 Feet High, to Impound 612,000,000 Cubic Feet of Water for Vancouver Island Power Company

A HOLLOW reinforced-concrete dam of the deck-slab and buttress type, having a maximum height of 126 ft. and a length of 756 ft., exclusive of 135 ft. of earth embankment, is the principal feature of the project to increase the capacity of the Vancouver Island Power Company's Jordan River plant to 25,000 hp by the addition of a 13,000 hp unit to the existing installation. The new dam will impound 612,000,000 cu. ft. of water, equivalent to 10,135,000 kw-hours, which, with the Bear Creek storage, is considered sufficient to run the enlarged plant continuously on a 50 per cent load factor throughout the dry season.

EXISTING PLANTS

The power plant is located at the mouth of the Jordan River, on the Straits of Juan de Fuca, 37 miles by water from the city of Victoria, B. C. Work on the development of the system was begun in 1909, and the first unit of 6000 hp was started in 1911. In 1912 a second unit of the same capacity was added, making the capacity of the plant 12,000 hp. Electrical energy is transmitted at 60,000 volts to Victoria, and a tie line connects this plant with the reserve steam plant at Brentwood Bay. Until last year the water supply for the Jordan River plant was taken direct from the main stream and carried through 5½ miles of flume to a forebay reservoir, whence steel pipe lines led to the power house. The necessary storage capacity was obtained by the construction of a hydraulic fill dam on Bear Creek, which formed a reservoir with a capacity of 327,900,000 cu. ft. The features of design and construction of this initial development were described in the Engineering Record of Oct. 19, 1912, page 436. On account of the increased load on the system it was decided to increase the capacity of the Jordan River plant, and the additional storage has been provided by the construction of a reinforced-concrete dam, of the Ambursen type, the subject of this article. The dam is located about 1200 ft. below the old diverting dam at the head of the flume. Surveys had shown that at this point a rock foundation was available.

The total reservoir capacity of the Jordan River system, for which only the Bear Creek and Jordan River dams have been completed at present, is shown in the table in the next column.

In deciding upon the type of dam to be constructed for the storage increase the choice lay between a hollow, reinforced-concrete dam and a solid concrete dam with either a straight or curved axis. The rock foundation was considered entirely suitable for either type. Test pits had shown that the average depth of bedrock below the ground surface was only 6 to 8 ft., and the maximum depth was about 20 ft. The transportation of materials, supplies and plant was an important item affecting the choice of the type of dam, as all freight had to be transported on scows from Victoria to Jordan River, there transferred to cars and taken 2 miles over an inclined cable tramway, then transferred again and hauled by horses or a small locomotive over 5 miles of track located above the flume. Sand and crushed rock for concrete could be manufactured at the dam site by opening a quarry and installing crushers and rolls.

RESERVOIR CAPACITIES OF THE JORDAN RIVER SYSTEM

	Cu. ft.
Bear Creek (completed)	327,900,000
Jordan River (completed)	612,000,000
Jordan Meadows (proposed)	980,000,000
Alligator Creek (proposed)	352,000,000
Wye Creek (proposed)	241,000,000
Total	2,512,900,000
Bear Creek raised 20 ft. (feasible)	287,000,000
Total	2,799,900,000

Time of construction was also an important consideration, for the company was very desirous of storing a good part of the 1913 spring runoff. Under these conditions a hollow-type dam was considered most suitable, and in August, 1912, a contract was let to the Puget Sound Bridge & Dredging Company, of Seattle, Wash., representing the Ambursen Hydraulic Construction Company, for the construction of a hollow reinforced-concrete dam.

RAINFALL AND RUNOFF

The storage capacity that would be afforded by dams of different heights built at this point was made the subject of a careful study before the height adopted was decided upon, and in connection with this study all the rainfall and runoff data available for this district were collected. The watershed of the entire Jordan River system covers about 67 sq. miles, of which 55 sq. miles, lying at elevations between 1200 and 3000 ft., are tributary to the reservoir just completed. The country is extremely rough and broken and is almost uniformly covered with a heavy growth of timber and underbrush. There are many precipitous rocky slopes and a few small swamps near the summits of the mountains which surround the basin. The geological formation of the northern part of the basin is a coarse slate, but the southern part is a very hard trap rock containing seams of serpentine. The latter formation underlies the dam.

A rain gage was installed at the mouth of the Jordan River in 1908, from which continuous records are available, and in 1911 a second gage was established at Bear Creek, 12 miles inland from the power house and 1300 ft. above sea level. In these gages lamps are used for melting the snow, which falls so that the figures represent the rain equivalent of the 6 to 10 ft. of snowfall which usually begins late in December. The snow lies on the ground until May or June. The precipitation is shown in the following table:

RAINFALL IN INCHES

Year	Jordan River	Bear Creek
1908	76.17	......
1909	79.59	......
1910	78.48	......
1911	62.92	84.14
1912	60.33	101.03

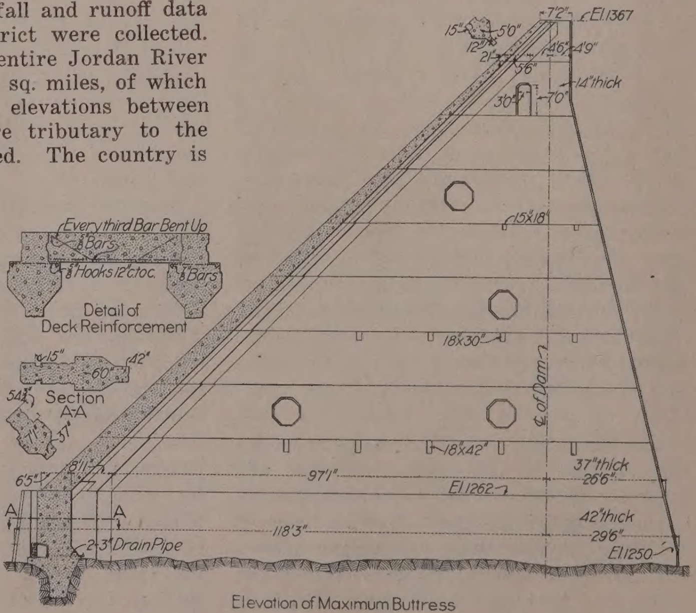
The average rainfall over the entire watershed varies from about 70 in. per year at the power house to more than 100 in. per year at the higher elevations.

By comparison with other rainfall records in the district it was found that 1911 was a minimum year. During this year the average runoff tributary to the Jordan River reservoir was 250 sec.-ft.

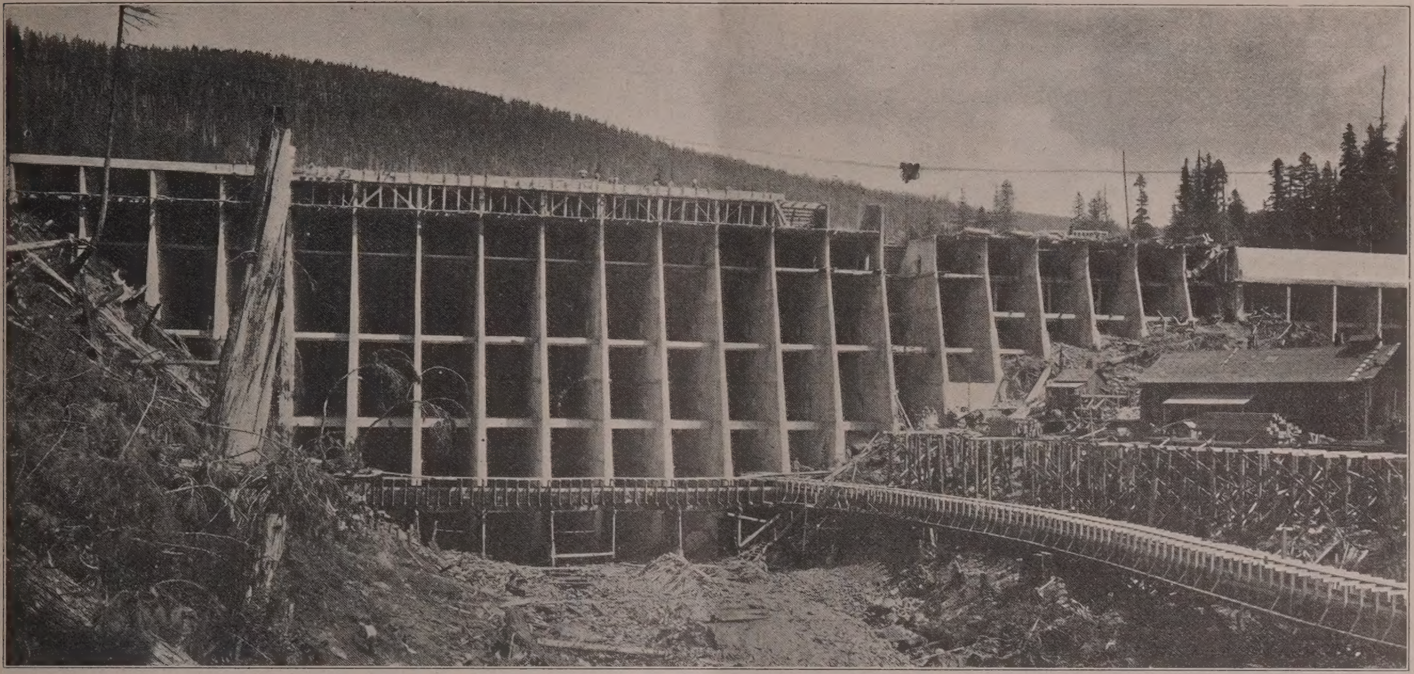
FEATURES OF THE DAM

The total length of the dam is 891 ft., which includes 450 ft. of bulkhead or non-overflow section, 306 ft. of spillway and 135 ft. of earth embankment with reinforced-concrete core wall. The spillway is located well toward the east end of the dam and has a freeboard of 8 ft., which provides for a flood discharge of 25,000 sec.-ft. The curved crest and rollway apron of the spillway discharge the water clear of the toe of the dam and into a natural channel, down which it flows to connect with the main river channel, about 200 ft. below the dam.

Forms for Inclined Concrete Deck



Details of Buttress and Deck Reinforcement



Downstream Face of Jordan River Dam, Showing Temporary Flume Crossing Stream Bed

The buttresses are spaced at 18-ft. centers. They are 12 in. thick at the top and increase by steps at intervals of 12 ft. to 42 in. in thickness at the bottom of the deepest buttress. The front or upstream edge of the buttresses is built on a slope of 1 to 1 and the downstream edge has a batter of 1 to 4 to a point 18 ft. below the crest, from which point it is vertical. Heavy haunches or shoulders are built near the upstream edge, and these support the decks. The buttresses are heavily reinforced horizontally with $\frac{7}{8}$-in. square rods, but are reinforced vertically only along the edges and in the haunches. The tallest buttress has a height of 126 ft. above the flooring. Reinforced tie beams connect the buttresses at various elevations to give lateral strength. In these tie beams the reinforcement is continuous through each three consecutive buttresses.

DECK SLABS

On the crest of the bulkhead section of the dam there is provided a walkway 6 ft. wide, which is protected by suitable handrails and connected at each end of the spillway by stairs with a second walk which passes entirely through the dam. The decks or faces of the dam were built after the buttresses were poured. They are supported on the buttress haunches and are keyed to the buttress projection by two bonding grooves left in the concrete. The deck thickness varies uniformly from 15 in. at the top to 55 in. in the deepest part of the cutoff trench excavated in the bedrock along the upstream toe of the dam. The horizontal reinforcement consists of $\frac{7}{8}$-in. square rods on 4-in. centers in the lower portions and $4\frac{1}{2}$-in. centers after reaching a level 45 ft. below the crest. Alternate rods are bent up to form a truss and to take the shear. The vertical reinforcement consists of $\frac{5}{8}$-in. square rods. The reinforcement in the decks and buttresses is not connected in any way.

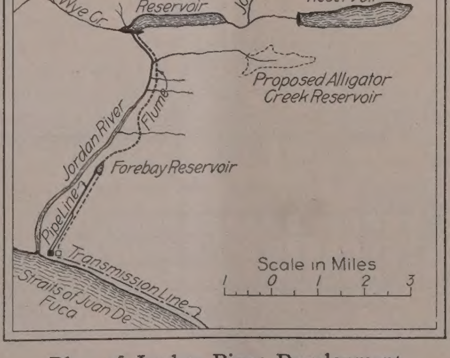
Only two sizes of reinforcing rods were used in the entire structure, these rods being $\frac{7}{8}$ and $\frac{5}{8}$ in. square. The $\frac{5}{8}$-in. rods were only used for hooks and light vertical reinforcing, the $\frac{7}{8}$-in. rods being specified for the greater part of the work.

All concrete in the decks, cutoff, beams and rollway was mixed in the proportion of 1:2:4. In the buttresses the mixture was 1:3:6. The total quantity of concrete in the dam is 21,185 cu. yd., for the reinforcing of which 380 tons of steel were used.

FLUME INTAKE

The old flume followed the eastern bank of the river, but because the spillway was on that side it was necessary to relocate about 600 ft. of flume just below the dam on the west bank of the river. About 600 ft. below the dam a concrete arch with an 80-ft. span was built across the river to bring the relocated flume over to a junction with the old line on the east bank.

Preliminary work at the dam, such as clearing the site and constructing camps, occupied about a month, and on Sept. 1, 1912, the work of excavating for the foundations was commenced. The profile of the site is such that work could be prosecuted on any part of the structure, except in five bays in the river bed proper, irrespective of flood conditions of the stream. This fact proved of the utmost value during the late fall and early spring months, when the river was subject to sudden and destructive floods.



Plan of Jordan River Development

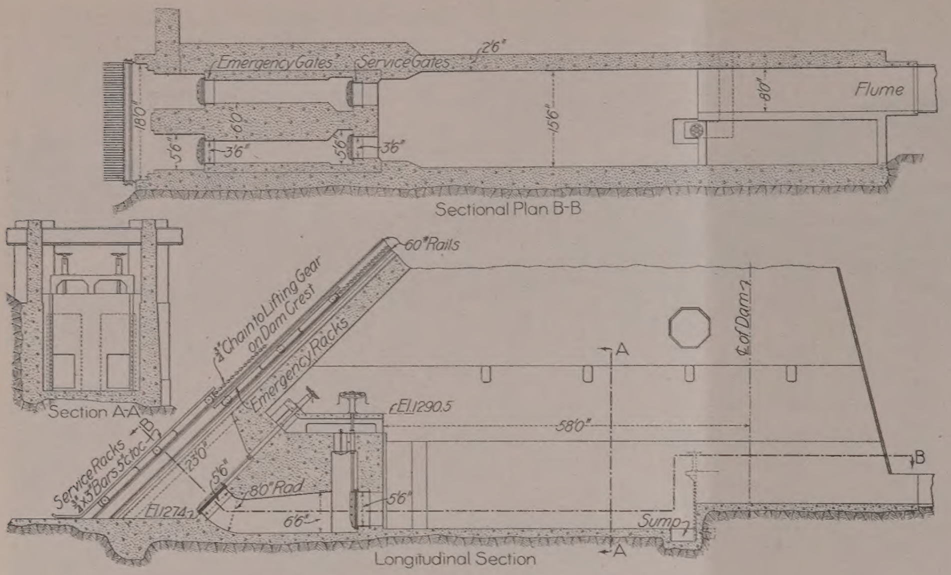
On exposure the rock underlying the site proved to be free from faults and well suited for foundation purposes, and it was not difficult to secure a satisfactory cutoff for the entire length of the structure. The possibility of water getting under the cutoff was greatly reduced, it was thought, by the fact that the grain of the rock, and therefore any seams that might exist, ran parallel to the axis of the dam and nearly vertical. The only serious difficulty encountered in the foundation work was the impossibility of building tight cofferdams on the loose gravel and boulders in the river bed.

FOUNDATIONS

The excavation to bedrock for the foundations was not made over the entire base of the dam, but trenches were put down along the lines of the buttresses and cutoff wall. Part of the material excavated from the foundations was removed by the aid of two stiffleg derricks with 50 and 60-ft. booms handling 1-cu. yd. skips, but practically all of the excavation behind the cofferdams in the river bed and on the steep west bank was done by hand work with wheelbarrows. Most of the material excavated was piled on the upstream side of the cutoff trench.

A quarry was opened on the hill just above the east end of the dam, the quarry equipment consisting of one 8 x 12-in. steam-driven air compressor operating two Ingersoll-Rand drills.

The crushing plant was located just below the quarry, from which the rock was conveyed to the crushers in 1-cu. yd. Koppel cars. The crushing plant consisted of two No. 2 Aurora jaw crushers, one rotary sand screen and two 16 x 30-in. Superior sand rolls. The crushed rock and sand were stored in bins, which fed by gravity into the mixing plant. Near the charging deck, where cement was measured into the mixers, storage was provided for



Flume Intake Details and Gate Chambers

about 5000 sacks of cement. The major portion of the mixing was done by a 1-cu. yd. Chicago mixer placed so as to discharge into 1-cu. yd. center-dump buckets standing on small flat cars. These cars were pushed by hand under the cableway by which the empty bucket was deposited on the car and the full one picked up. Concrete was dumped from the buckets on the cableway into hopper bottom cars running on tracks on top of the buttress forms, and was distributed as desired from these cars.

CONCRETE FORMS

The forms used were of the standard sectional type as developed by the Ambursen company. They were substantially built of heavy timber frames and 2-in. facing. One full set sufficed to build the entire dam. The bottom forms for the decks were supported on purlins, the ends of which rested on shoulders on the buttress haunches. The top deck forms were secured in place by "strong backs" or trussed beams bolted down to the buttresses by means of 1¼-in bolts spaced 2 ft. apart. These bolts were placed in pipes when the buttresses were poured. They were threaded on both ends and were provided with a nut on the embedded end, so that after the removal of the forms the bolts could be unscrewed and removed and the pipe filled with grout. Nearly all of the form sections were placed by the cableway, which also handled the concrete.

The cableway had a span of about 950 ft. The standing line was a 2¼-in. cable on which a heavily built carriage was operated by a two-spool steam-driven Flory engine. The work done by this cableway is said to have been very creditable and very little time was lost on account of repairs.

Warehouses were provided at the head of the railroad for storing 75,000 sacks of cement. The cement was taken by horse cars from the warehouses to the cableway, which conveyed it to the mixing plant. All cement used in the dam was tested in a field laboratory as well as by an independent testing laboratory. All the cement proved to be satisfactory before it was used, although two or three shipments had to be stored to overcome "greenness."

FLOOD DAMAGE

It was planned to take advantage of the low stage of the river and get the buttresses which stand in the river bed concreted above the water line before the floods came. Various causes delayed the progress of the work and not until Sept. 30 was the mixing plant in service. A cofferdam had been built and pouring was at once commenced on the footings of the two buttresses in the stream bed, between which provision was made for diverting the flow of the river. Good progress was made up to Nov. 10, at which time a heavy flood swept down the river and destroyed most of the cofferdam, turned over the first section of one of the buttresses and carried away the forms from a second buttress.

For several months construction was confined to those parts of the foundation work above the high-water line. During December and January there was a snowfall of about 9 ft., which made transportation difficult, hindered the operation of the quarry and delayed the progress of the work generally. On Feb. 18 work was resumed in the river bed, although a good deal of cofferdamming and consequent heavy pump installation were required.

The work on the buttresses was sufficiently advanced to turn the river through the temporary channel between two of them by the first of March. Work was then started on the other buttresses in the deep portion of the river channel in an effort to get the dam completed to a sufficient elevation to permit a permanent closure in time to store some of the spring runoff.

TEMPORARY FLUME

No serious delays occurred in the spring months, and by the latter part of April the decks were in place up to El. 1310. Three weeks were allowed for the concrete to set, and on May 22 the flow in the temporary pass through the dam was closed off by means of stoplogs. Meantime the permanent intake opening had been completed and, pending the construction of the concrete bridge, a temporary flume connection was provided to maintain the water supply to the power house. This flume is shown in one of the accompanying photographs, crossing the stream bed immediately below the dam to join the old flume line. All of the flume shown in this view will be abandoned when the permanent flume construction is in service.

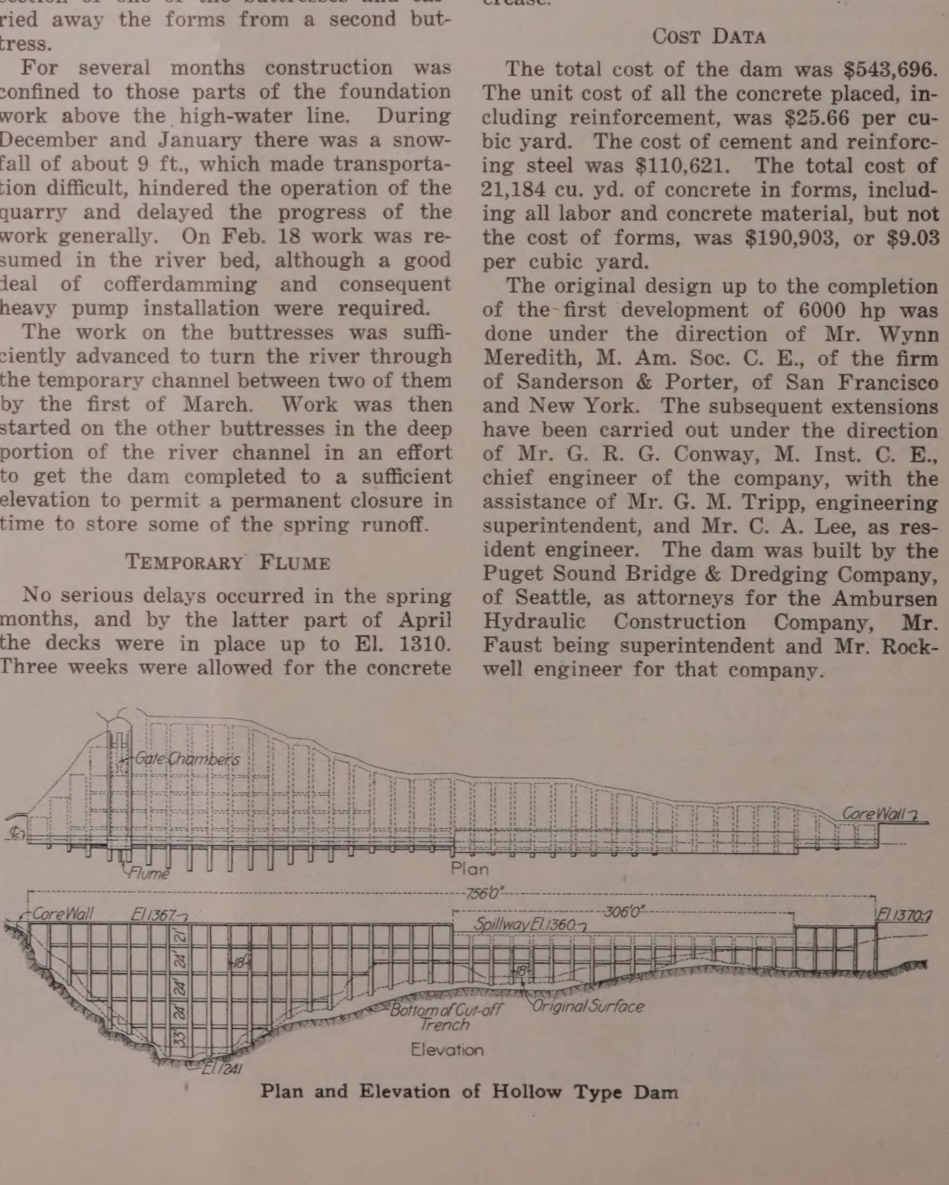
At the time of closure the river flow was about 300 sec.-ft. and under this flow the reservoir gradually filled until the water behind the dam reached El. 1310, at which level it was held by opening the outlet gates. Owing to an unusually cold spring and late rains there was more than the usual stream flow in the early summer, and this was allowed to fill the reservoir as fast as the concrete in the deck hardened. By the middle of July the water had reached El. 1338.2, after which the runoff decreased so that the water level fell about 7 ft. by Aug. 1. On Oct. 10 the water level stood at El. 1354, or 6 ft. below the spillway crest. On that date more than 4 in. of rain fell within twenty-four hours, and the lake rose rapidly, until on Oct. 11 the water flowed over the spillway at a depth of 3.1 ft. At this depth the rate of runoff was more than 6000 sec.-ft.

Under the maximum head there are only a few very small leaks through the decks, and these are showing signs of gradual decrease.

COST DATA

The total cost of the dam was $543,696. The unit cost of all the concrete placed, including reinforcement, was $25.66 per cubic yard. The cost of cement and reinforcing steel was $110,621. The total cost of 21,184 cu. yd. of concrete in forms, including all labor and concrete material, but not the cost of forms, was $190,903, or $9.03 per cubic yard.

The original design up to the completion of the first development of 6000 hp was done under the direction of Mr. Wynn Meredith, M. Am. Soc. C. E., of the firm of Sanderson & Porter, of San Francisco and New York. The subsequent extensions have been carried out under the direction of Mr. G. R. G. Conway, M. Inst. C. E., chief engineer of the company, with the assistance of Mr. G. M. Tripp, engineering superintendent, and Mr. C. A. Lee, as resident engineer. The dam was built by the Puget Sound Bridge & Dredging Company, of Seattle, as attorneys for the Ambursen Hydraulic Construction Company, Mr. Faust being superintendent and Mr. Rockwell engineer for that company.



Plan and Elevation of Hollow Type Dam

Merger of Harvard and Massachusetts Institute of Technology

Two Great Educational Institutions Agree to Co-operative Plan for Conduct of Courses in Mechanical, Electrical, Civil and Mining Engineering

HARVARD UNIVERSITY and the Massachusetts Institute of Technology are to combine resources in what is probably the greatest educational merger ever effected. By a coincident vote on Jan. 9 the overseers of the university and the corporation of the institute agreed to co-operation in the conduct of the four courses leading to degrees in mechanical, electrical, civil and sanitary engineering, and mining engineering and metallurgy, and in the promotion of research in those branches of applied science.

The basis of the agreement which has been entered into by the two great institutions is that the university and the institute are to remain absolutely unaffected in name, organization, title to and rights over property or in any other way not specifically mentioned in the agreement. Each is to retain complete control of its own financial resources. Each is to be free to lay down such regulations as it likes with regard to the courses leading to its own degrees.

CO-OPERATION LIMITED

The co-operation is definitely limited to the great fields of engineering—mechanical, electrical, civil and sanitary and mining—all of which involve great expense in the maintenance of extensive and costly laboratories. In the interests of efficiency and convenience, for the concentration of effort and the elimination of waste and lost motion, it is agreed that all the work of education and research in these important branches of applied science shall be carried on within the buildings of the institute to be erected on its new site in Cambridge, bordering on Massachusetts Avenue and the Charles River Embankment. These buildings are being erected, arranged and equipped to surpass all others in fitness for their purpose.

For the maintenance and equipment of these laboratories and the payment of salaries, the university agrees to set aside practically all the money that it would otherwise be free to devote to education of this type. Technology, on its part, agrees to devote to the same general purpose all the funds or the income of funds that it now holds for carrying on work in the departments of engineering that have been named, and both institutions agree that their respective measures of support may be increased from time to time if disposable funds are available.

Since the work of education and research in these great fields of education is to be carried on within the walls of Technology, it is provided—and this is for business convenience—that the money available shall be expended through the bursary of the institute and the work carried on under the executive control of the president of the institute. As an evidence of his responsibility in directing this work, the president is to make an annual report to both corporations, and when in future the corporation of the institute is selecting its president, the president of Harvard is to be invited to sit with the committee that recommends the appointment of that president.

The faculty of Technology shall be enlarged by the addition to it of the professors, assistant professors and associate professors of the four departments in the Harvard Schools of Applied Science, who, retaining their titles and privileges in Harvard University, will acquire the corresponding titles and privileges in the institute. Similarly, the officers of corresponding rank in the four departments in the institute will acquire the same titles and privileges in the university. The work of instruction and the laying down of courses leading to degrees is intrusted to the enlarged faculty.

FACULTY APPOINTMENTS

Within the departments of mechanical, electrical, civil and sanitary and mining engineering, both corporations will be concerned with the appointments of the instructing staff, but neither corporation will be called upon to make any payment of salary to a professor whose appointment has not been formally approved by it. The enlarged faculty will have a double duty to perform: Under regulations from the institute's corporation it will lay down engineering courses that lead to the degrees of the institute, and under regulations from the university will lay down comparable courses that lead to the degrees of the university; unless the regulations of the two corporations are different, the courses leading to both degrees will almost certainly be identical.

Since the work is to be done within the New Technology at Cambridge, the full accomplishment of the co-operation must wait a couple of years till the structures are finished. It is understood, however, that temporary arrangements will be made whereby some of the benefits of the agreement may be gained without so much delay.

The agreement is now complete, since it has been formally adopted and approved by the properly constituted authorities.

PRESIDENT LOWELL'S COMMENT

From the point of view of Harvard University, its president, A. Lawrence Lowell, makes the following statement, which shows the broadness of spirit with which his institution enters into the agreement:

"Friends of Harvard University and the Massachusetts Institute of Technology—and they have many friends in common—have long deplored the rivalry of two schools of engineering competing on opposite sides of a river. The disadvantages have been made even more evident by the decision of the institute to cross the Charles; but the difficulty of making an arrangement satisfactory to both parties has hitherto been very great, and in fact, the obstacles to a combination between rival institutions supported by and serving the same community have been one of the grave defects of higher education in America. This difficulty seems at last to have been overcome by a plan for co-operation in the conduct of one school of engineering and mining. The plan is favorable to both institutions. Both gain thereby. Which gains the most can probably not be determined, and certainly has not been computed; for the leading motive with the authors of the agreement has lain in another plane. Both institutions exist for the promotion of instruction and research. Each is a means to an end larger than itself—the welfare of the community as a whole. That both acting in concert can further this end better than either working alone cannot be doubted. By the combination of resources and momentum a school ought to be maintained unequalled on this continent —and perhaps in the Old World."

VIEWS OF PRESIDENT MACLAURIN

In behalf of Technology, President Maclaurin speaks thus of its acceptance of what it deems to be a movement that is for the benefit of the people:

"The advantage of co-operation between the institute and Harvard have long been the subject of discussion. With reference to the present plan of co-operation, I beg to make the following statements:

"The Honorable Richard Olney, in a carefully considered legal opinion, says: 'Co-operation between educational institutions for a legitimate purpose common to both is certainly not illegal and in this case wholly desirable. The agreement seems to me to spell co-operation and nothing more, involves no merger of corporations or their property interests, and can be carried into effect without violation of charters or of the trusts upon which funds are held.'

"Its adoption by the corporation is unanimously recommended by the executive committee.

"It is approved by each of the last five presidents of the Alumni Association, and by the president-elect. The president of the Alumni Association, Mr. Frederic H. Fay, writes: 'I heartily commend this effort on your part, and I believe that when it is found that an agreement, such as you have proposed, can be carried out to the satisfaction of the authorities of both institutions, you will find that you have the great body of Tech Alumni behind you, and that you will have added to the prestige and usefulness and strength of the institute.'

"It is approved by all the heads of the institute's departments that are directly affected and by all the other senior members of the faculty who have been consulted with reference to it.

"It leaves the institute so entirely independent that it can appoint any officer or instructor that it pleases; it can appropriate its funds as it pleases, and it can make any regulations that it pleases with reference to the courses leading to its degree.

"I believe that the adoption of this agreement is a forward step of very great import to the future of education in this country. Incidentally, it would be of great advantage to each of the co-operating institutions, but it would be especially significant in the emphasis that it would give to the fact, so often overlooked, that educational institutions do not exist for themselves and that their sole duty is to make the best provision that can possibly be made for those who are rising to manhood and for their successors. Under the scheme of co-operation here proposed it would be possible to maintain a much stronger school of applied science than either institution alone could furnish, and it would be possible to keep that school practically unrivalled in America—and, indeed, in the world."

Specifications for Factory Timbers

Dissenting Views as to Relative Value of Abundance of Resin and Low Percentage of Sapwood for Retarding Dry Rot in Mill Buildings

DEPLORING the prevalence of dry rot in the timbers of mill buildings, especially those in which there is high artificial humidity, Mr. F. J. Hoxie, of Phenix, R. I., proposed remedies at the recent annual meeting of the American Society of Mechanical Engineers. The January "Journal" of the society, from which these notes are taken, contains his paper and the discussion thereon. Mr. Hoxie's main contentions are that the percentage of resin in hard pine can be taken as an index of its power of resistance to rot, that from 3 to 5 per cent of resin should be the low allowable limit, and that inability to get hard pine in suitable quantities with this minimum percentage makes antiseptic treatment of the important parts of a mill imperative for safety. He presents numerous illustrations of rotted timbers, the decay in each case being in parts where the percentage of resin was low. He also cites an experiment where a block of longleaf pine was sawed in two, the resin being boiled out of one piece and left in the other. At the end of a year, when the specimens were dried and weighed, it was found that while the piece from which the resin had been removed had lost 8 per cent in weight, the other had lost only 2 per cent.

Mr. Hoxie regards it as unfortunate that the American Society for Testing Materials calls all good material longleaf pine and all poor material shortleaf, regardless of botanical characteristics. This arbitrary distinction, in his estimation, makes the positive identification of longleaf pine lumber difficult or impossible. Among his illustrations are rotted beams which may be either longleaf or shortleaf. In eight 12 x 16-in. beams of average good quality samples taken for resin analysis showed that in no case was there 5 per cent of resin throughout. In order to get this maximum percentage he thinks a price of $115 per 1000 ft. would have to be paid instead of the $59 actually paid. Hence he concludes that suitable material to resist fungus growth is no longer available at reasonable prices, and that preservative treatment must therefore be employed.

Abstract of Comment by Von Schrenk

To these conclusions Dr. Herman von Schrenk, consulting timber engineer, of St. Louis, takes emphatic exceptions. In his estimation the percentage of resin has little to do with the question. He believes it to be almost wholly a matter of getting the proper percentage of heartwood; he contends that there is still plenty of suitable hard pine available from the South, and that it is simply a question of proper specifications and inspection to see that timber high in sapwood is excluded. His discussion is more fully abstracted below.

In regard to resin as a factor in preventing decay, the only proof which the author presents is a cultural test made with two pieces of pine wood. To one familiar with the behavior of fungi, the cultural proof submitted is of no value whatever. The reasons fungi grow on one piece and not on another may be due to the moisture content, to the density of the wood fiber, to the presence or absence of various compounds, and to many other factors not referred to by the writer.

Numerous investigations have been made from time to time with relation to resin and fungus activity. Personally, I am of the opinion that the only function which resin has with respect to fungus growth is to act as a waterproofing material. A piece of pine wood having 10 per cent resin would be very resistant to moisture. Resin of itself is not an antiseptic. This may be illustrated by the fact that even in the most resinous trees wood-destroying fungi grow with the greatest ease.

Too Much Sapwood

It is unquestionably true that recent experience in various mill construction buildings has shown an increasing percentage of timbers infected with dry rot. I consider it wholly unnecessary, however, to ascribe this to such a problematic factor as the resin content. I have personally examined a good many of the recent cases, and invariably find that where such decay has taken place it has been in timbers having a high percentage of sapwood. It has been recognized for many years that the relative resistance to decay of sapwood and heartwood is very marked. Sapwood decays rapidly and heartwood comparatively slowly. The proposal of the author to consider the resin percentage as a standard, and his attempt to figure the value of a piece of timber for use on the per cent of resin as a basis, is so extreme that I hardly consider it worthy of refutation. At best, the engineering profession should go slowly before accepting so radical and unproved a suggestion, based as it is upon a comparatively small number of laboratory experiments, which, so far as can be judged from the paper in hand, failed to take into consideration the numerous conflicting factors usually eliminated in such cultures.

Meaning of "Non-Resinous"

The second point brought out by the author is that the hard pine timbers now available are practically all non-resinous. The impression given by the paper is that years ago there were a lot of timbers which come under the group of resinous timbers, but that these have now disappeared. A possible change which might have taken place in the resinous character of the pines in the last 10 or 15 years is that during that period many of the longleaf pines have been tapped for turpentine, and this possibly may have given rise to an impression that removing the turpentine from the pine tree makes it less resinous. This is certainly true so far as certain portions of the sapwood are concerned, but it is not true of the heartwood.

The resinous materials of the pine tree which are removed from the tree during the turpentining operations come from the liquid portions contained in the sapwood resin canals. I am inclined to believe that Mr. Hoxie drew his conclusions from a comparatively small number of sappy pieces; at least I would characterize his generalization as decidedly without foundation. The variable in the resin content of pine timbers is obviously very great, and this is well shown in the analysis which he presents.

Mr. Hoxie admits that there are still available four species of pine in the South, but he makes the very strong statement that hard-pine lumber 12 in. square or larger is not obtainable in suitable quantities without antiseptic treatment. According to the last report of the United States Bureau of Corporations for 1913 there are still standing in the Southern States 384,000,000,000 ft. of yellow pine timber, which the Bureau of Corporations classifies into longleaf pine and shortleaf pine. Of the 384,000,000,000 ft., 232,000,000,000 ft. are longleaf and 152,000,000,000 ft. shortleaf pine.

Longleaf and Shortleaf Pine

Assuming that the longleaf pine available is typical longleaf pine, no proof has been brought forward by the author of the paper that this is less fit for structural use than it was fifteen years ago. The difficulty of obtaining such longleaf pine timbers as were available fifteen years ago is, as the writer admits, largely a matter of specifications. The author criticises the American Society for Testing Materials' specification for adopting the terms "longleaf pine" and "shortleaf pine," going to the extent of characterizing this specification as "arbitrary." I would call attention to the fact that the classification "longleaf" pine and "shortleaf" pine is universally adopted not only by scientific authorities, but also by the lumber trade. The United States Bureau of Corporations, the Georgia-Florida Sawmill Association (annual cut about 800,000,000 ft.) and the Yellow Pine Manufacturers' Association (annual cut about 4,500,000,000 ft.) all divide yellow pine into longleaf and shortleaf pine.

Distinction between the Two Grades

It was for the reason that these commercial classifications are practically standard that the American Society for Testing Materials indorsed them. The problem of distinguishing between these two grades is a difficult one. I thoroughly concur with Mr. Hoxie that the line of demarcation between the two is very vague, and almost impossible to establish with any degree of accuracy. The American Society for Testing Materials suggests that the distinction between the two be based on the density, that is, on the number of growth rings per inch. This distinction may not be the best, but can be used when liberally interpreted where a botanical distinction is out of the question. Attention is furthermore called to the fact that the distinction on the basis of density, made by the American Society for Testing Materials, was largely from the standpoint of strength. No specific mention is made as to lasting power, because that factor was taken care of in the specification for bridge materials by separate clauses. Attention is called to the standard specification for structural timber adopted by the American Society for Testing Materials in 1907, in which for No. 1 longleaf pine stringers the specification calls for timbers which show not less than 80 per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece. For caps and sills the specification calls for 85 per cent heart on each of the four sides.

In other words, the American Society for Testing Materials' specification calls attention to the necessity of getting denser timber, and timber free from sap. Similar specifications are in force in the American Railway Engineering Association. The decayed specimens shown by Mr. Hoxie are largely sapwood, and would not begin to fulfil either of these two specifications.

LACK OF PROPER INSPECTION

The chief trouble with a good many of the failures has doubtless been that the purchaser has not given the timber the proper inspection. My main contention is that the important factor in the lasting of yellow pine in buildings is not the resin content of the timber, but the percentage of sapwood allowed on such timbers. In a recent building failure which I had to examine personally, in which a large number of timbers had failed, the failure was in timbers with a high percentage of sapwood; in the practically all-heart timbers there was only one case of decay, and that one was very slight.

If one specifies longleaf pine timbers for buildings, and strictly adheres to the specification, limiting the amount of sapwood, one will find that the timbers available will give just as good service, from the standpoint of length of life, as those furnished in the past. Many a producer of lumber has been remiss in furnishing sappy timber under a heart specification, and too much stress cannot be laid upon the necessity for care in not only specifying, but also inspecting every piece of pine timber intended for a building in which both strength and lasting qualities are important factors.

AUTHOR'S REPLY

In answering Dr. Von Schrenk, Mr. Hoxie claims that it has been a matter of common knowledge for centuries that resin retards the progress of rot. He has, therefore, not attempted to prove that it has such powers. He concedes that its waterproofing quality is its chief deterrent against rot, but thinks more information on the subject is desirable. What interests him especially, however, is the amount of the substance necessary to render mill timber reasonably safe for use under average conditions, and in the conclusions he has reached laboratory experiments have been the least important factor. Beams which have seriously rotted in place in several mills under average mill conditions have been used for most of his experiments. He differs with Dr. Von Schrenk as to the percentages of sapwood and heartwood in the decayed beams illustrated. He states that the percentages of sapwood were small, that more heartwood than sapwood was decayed and that the timber was fine-grained, conforming to the specifications for longleaf pine. Conceding that true longleaf pine is the same as it ever was, he holds that the name is being used for other varieties hardly distinguishable, and that the prevalence of these varieties, which decay rapidly under humid mill conditions, makes it necessary to apply antiseptic treatment to all pine used for the columns or beams of mills.

THE 50,000 HP purchased from the Ontario Power Company at Niagara Falls by the Hydroelectric Commission was not sufficient to cover a recent peak load on the system. The automatic circuit breakers opened and caused an interruption in the service for fully five minutes. As a consequence of the expansion of business the peaks of the various municipalities overlapped. A repetition of the incident has been forestalled by adjusting the breakers.

Filling and Emptying of Reservoirs

Graphical Solution of Problems Connected with Non-Prismatic Reservoirs under Varying Conditions of Inflow and Outflow

By THEODORE R. RUNNING

Assistant Professor of Mathematics, University of Michigan, Ann Arbor

PROBLEMS connected with the filling and emptying of non-prismatic reservoirs under varying conditions of inflow and outflow furnish very interesting applications of graphical methods. The fundamental equation of fluctuation of the water level is

$$(S - D)\,dt = A\,dh$$

where S = inflow or supply, D = outflow or discharge; A = area of water surface of reservoir; t = time, and h = depth. (See "Weir Experiments, Coefficients and Formulas," by Horton, Water-Supply and Irrigation Paper 200, page 154; and "A Mathematical Analysis of the Influence of Reservoirs Upon Stream Flow," by Seddon, "Proceedings," American Society of Civil Engineers, Vol. 24, Part 2, page 559.)

In general S will be a function of t; D and A will be functions of h. As the form of the above equation is generally such that the complete primative can be obtained only as an infinite series, it is desirable to have an approximate solution which does not involve a great deal of labor.

It is the purpose of this paper to show how graphical methods may be applied to the solution of the differential equation $dh/dt = (S - D)/A$, and made to yield results correct to a close approximation. (For other graphical methods of solving differential equation see Runge's "Graphical Methods," Columbia University Press, and "Sur un Integrateur des Equations Differentielles Ordinaires," by Roiloff, Bulletin de l'Académie Imperiale des Sciences de St. Petersbourg.) The numerical approximations to the solutions of differential equations are laborious and the probability of error great. (For a comparison of different numerical approximations see "Beitrag zur Näherungsweisen Integration Totaler Differentialgleichungen," by Kutta, "Zeitschrift für Mathematik und Physik," Vol. 46, page 435.)

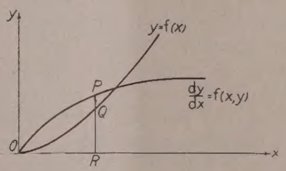


Fig. 1

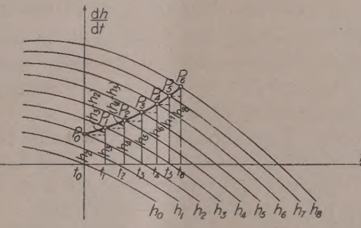


Fig. 2

The following solution depends upon the fact that the area under the derived curve is equal to the corresponding ordinate on the integral curve, so that in Fig. 1, for example, the area OPR is represented by the ordinate QR.

If in the differential equation

$$dh/dt = f(t, h)$$

we assign particular values to h and plot the equations thus obtained with dh/dt as ordinate and t as abscissa we shall obtain a group of curves as shown in Fig. 2, in which figure the curves are designated by the corresponding values of h.

Suppose the initial condition to be $h = h_2$ where $t = 0$. From P_0, the point where the curve h_2 crosses the axis of dh/dt, draw a curve, which, for an approximation may be a straight line, to P_1 on the curve h_3 such that the area under the curve P_0P_1 shall be equal to $h_3 - h_2$. The abscissa of the point whose ordinate is h_3 on the integral curve is t_1. From P_1 draw a line to P_2 on the curve h_4 such that the area under the line P_1P_2 shall be equal to $h_4 - h_3$. This process continued will give any desired number of points on the integral curve. The co-ordinates of such points given on the figure are $(t_0\,h_2)$, (t_1, h_3), (t_3, h_5), etc. For a close approximation squared paper ruled to one-twentieth of an inch is very serviceable in plotting this curve.

The following problem, which came up in engineering practice, will serve as an illustration: It was found by a series of observations, over the particular region involved, that the limits of water discharged into a reservoir basin during a flood could be represented by the expression $S = 1800\,t$, until a maximum was reached, after which the water discharged into the basin could be represented by $S = 1740 - 240\,t$, where S represented acre-feet per day and t time in days. The spillway was 40 ft. long and the water discharged over it could therefore be represented by $132\,h^{3/2}$ acre-ft. per day. By the application of the

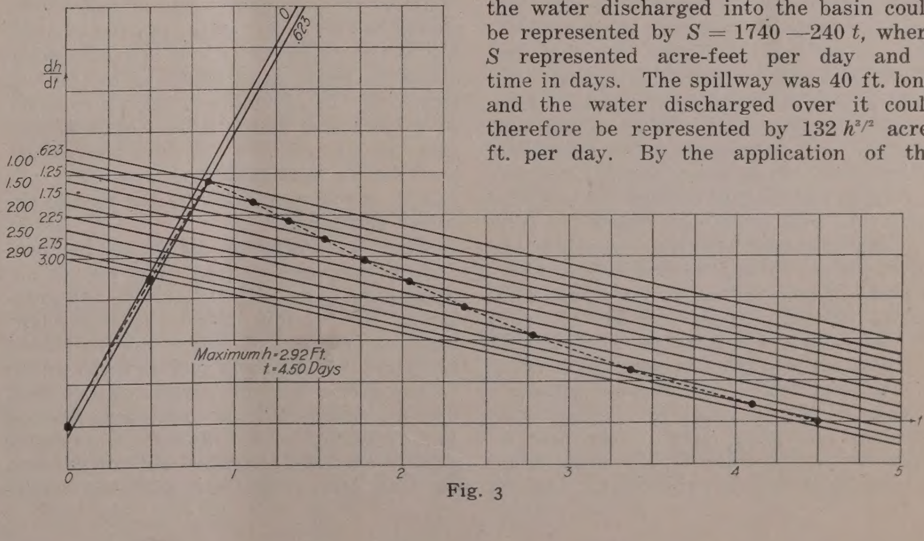


Fig. 3

method of least squares to the data obtained by a careful survey of the region it was found that the water surface of the reservoir could be represented closely by $A = 11\,h^{6/5} + 1000$ acres.

The problem was to find the maximum value of h and the corresponding value of t, and to obtain values of h at frequent intervals up to the maximum, together with the corresponding values of t.

The fundamental differential equations became, therefore, when the expressions for S, D and A were introduced

$$\frac{dh}{dt} = \frac{1800\,t - 132\,h^{3/2}}{11\,h^{6/5} + 1000} \qquad (1)$$

from 0 up to the maximum and thereafter

$$\frac{dh}{dt} = \frac{1740 - 240\,t - 132\,h^{3/2}}{11\,h^{6/5} + 1000} \qquad (2)$$

It was assumed that the bottom of the reservoir was at the same elevation as the spillway crest, so that for the initial condition $h = 0$ when $t = 0$. From the two equations, $S = 1800\,t$ and $S = 1740 - 240\,t$, the common value of $t = 29/34 = 0.853$ was then calculated. The first differential equation must be satisfied for values between $t = 0$ and $t = 0.853$, the second between $t = 0.853$ and $t = 7.25$. In the accompanying table are given sets of values of h and dh/dt.

VALUES OF h AND dh/dt

Equation (1)		*Equation* (2)	
h	dh/dt	h	dh/dt
0.0	$1.8t$	1.75	$1.402 - 0.2350t$
0.5	$1.791t - 0.046$	2.00	$1.333 - 0.2341t$
0.623	$1.789t - 0.065$	2.25	$1.258 - 0.2332t$
Equation (2)		2.50	$1.179 - 0.2323t$
0.623	$1.665 - 0.2385t$	2.75	$1.097 - 0.2314t$
1.00	$1.591 - 0.2374t$	2.90	$1.047 - 0.2309t$
1.25	$1.534 - 0.2366t$	2.95	$1.031 - 0.2307t$
1.50	$1.471 - 0.2358t$	3.00	$1.011 - 0.2305t$

The value 0.623 for h is obtained by so selecting the derived curve that the area under the dotted line in Fig. 3 from $t = 0$ to $t = 0.853$ is equal to the corresponding value of h.

These equations are plotted in Fig. 3 and the derived curve shown by the dotted line; h will be a maximum when dh/dt = 0, which occurs 4½ days after the flood begins and its value is 2.92 ft. More points on the integral curve can readily be obtained. Beyond the point where h is a maximum dh is of course negative and the areas will be negative. Points on the integral curve are

t . .	. . . .	0	0.5	0.853	1.125	1.32	1.54
h . .	. . . .	0	0.212	0.623	1.00	1.25	1.50
t . .	1.78	2.05	2.37	2.78	3.38	4.11	4.50
h . .	1.75	2.00	2.25	2.50	2.75	2.90	2.92

The method has an interesting application to the solution of some forms of the differential equations of the second order.

Engineers' Part in Regulation of Public Utilities

Abstracts of Papers Read before the Alumni of Stevens Institute of Technology at Their Annual Convention on January 9

Need for Engineers as Commissioners and Not Employees

By ALEXANDER C. HUMPHREYS

President of Stevens Institute of Technology

A COMMISSION or any other one government authority should not be placed in office to exercise the three functions of government, which, according to our bill of rights, should be kept separate and distinct from each other—namely, the legislative, the executive and the judicial. Admittedly, there should be some measure of control of public utilities, and particularly if these public utilities are to be protected in monopoly. But because there should be some measure of such control it by no means follows that national and State commissions should therefore be given a free hand in the management of these properties. Those responsible to the owners must be permitted to manage the properties if efficiency and economy are to be obtained and maintained.

In a country like ours we cannot close our eyes to the facts as to how appointments to any such offices are too often obtained. They are part of the spoils of party victory and control. Those of us who have come into close contact with these commissions know that too often the men appointed are not qualified to exercise the great power placed in their hands. If we examine the personnel of some of our commissions and inquire into their previous training and experience, what right has anyone to believe that certain of these men when they took office were capable of solving the intricate technical questions involved in their attempts to regulate and control the public service corporations committed to their tender mercies? It goes without saying that there are men on these commissions who are well equipped in every way to meet their grave responsibilities.

Many of the questions which these commissions are called upon to determine require for their solution the highest engineering training and experience. And yet it is the exception when an engineer is appointed as a commissioner. The engineering profession is most often represented not as members of the board but as employees of these boards, and so with no vote. Frequently the engineers so employed as subordinates to the commissioners are not qualified for an authoritative position in any of the companies over which they are thus given, indirectly it is true, a large measure of authority. On every one of these commissions the engineering profession should be adequately represented in the persons of men educated in the science of engineering and later trained in the hard school of experience.

BROAD TRAINING REQUIRED

By no means is a man because he is an engineer necessarily qualified for membership on such a board, any more than a man is qualified to be a judge because he is a lawyer. Whether the commissioner is engineer, lawyer, accountant, or business man, he should be broadly trained and should have had experience in the exercise of administrative functions. In character he should be above reproach; he should be judicial in temperament, and particularly he should be free from the temptation of playing to the gallery. This is a hard specification to meet, particularly as to the last item. On the other hand, can we conceive of a class less fitted to be commissioners than the statisticians who have not had experience as administrators and have not had their theories tested by the results obtained therefrom?

When we consider that all of the productive processes of life in one way or another have to do with the science and practice of engineering, it seems extraordinary that the members of our profession should have been permitted to such a slight extent to enter this field of government control. The engineers as a class are themselves in part to blame, for not taking a more active part in the administrative side of life and for not deliberately and advisedly equipping themselves for administrative responsibilities.

By no means do I suggest that there are not a sufficient number of engineers in the country, specifically and broadly trained, to do their full share on the commissions of the country; but they should be selected with regard to their breadth of training quite as much as for their special training. The same rule should be applied in the selection from the ranks of other professions, and particularly that of the law.

With the all-pervading character of engineering in mind, every commission in this country should have at least one engineer as a full member; and I believe it would be better if the engineering profession were more fully represented than any other profession. Especially are we inclined to favor the inclusion of more than one engineer on each board, when we think of the many branches of engineering represented in the several utilities coming under control of these commissions. I see no reason why a board composed say of five broadly trained engineers, with a competent lawyer to advise them, should not be able to render quite as efficient service as five well-equipped lawyers as commissioners with one competent engineer to advise them. I am willing to go still further and say that if we must confine the membership of a commission to a single profession, then the commission of five broadly trained engineers with competent legal assistants on the staff would give far better results then, on the average, have so far been obtained.

The best results, I believe, would be obtained by selecting the majority of commissioners from the professions of law and engineering, no commissioner to be selected unless he has had working experience and been successful under the test of that experience. This would exclude the man who has spent his life on the development of fine-spun theories; and if applied to these now in office would, I fear, create not a few vacancies.

In conclusion let me emphasize two points. First, as a general proposition, the great corporations which, by some, are thought to be a menace to the country have not won their successes by financial legerdemain. In some cases manipulation of finances has had an influence, though not always detrimentally. Great problems were to be solved, physical and financial, and they were solved only by the patient, persistent, determined prosecution of plans boldly conceived by promoters—and generally carried through temporary failures to final success by the united efforts of bankers, men of affairs, engineers, and others, not forgetting the small investors. These pioneer labors have been for the benefit of the country as a whole, and therefore it ill becomes the representatives of the people to-day to deny to these pioneers and their successors a rightful participation in the fruits of these hardly won successes. Second, with regard to the public utilities, the legislation and regulation which in the final analysis will stand the test of time and will accord justice to the producer and consumer must take full account of the inherent physical and financial limitations within which these properties are forced to operate. To this end men technically trained in all branches of public utility construction and operation must have their full share in the formulation of the regulatory laws and the administration and enforcement of these laws.

How to Get Better Commissions

By NEWCOMB CARLTON

Vice-President, Western Union Telegraph Company

TWO facts appear to be established by President Humphreys—that the personnel of public-service commissions in general is far from satisfactory and that the commissions would be much more equitable, judicial and competent by the addition of members technically trained and experienced as engineers. I cannot, however, conceive of engineers in any number that fulfil his requirements and are available for the purposes of commission control. An engineer possessing sound technical knowledge, coupled with broad administrative experience, is much sought; he is, in fact, a rara avis, and usually well supplied with position and emolument which place him beyond the call of public-service commissions as now constituted. I am leaving out of consideration patriotism as a controlling motive in his decision, since I venture the belief that any appointment requiring patriotism as the moving argument for consent will find too few well qualified to meet the demands.

However, we must admit that regulation has come to stay and that its failure means recurrence to the very worst features of the old-time lobbyists and legislative corruption; hence we must find a way to make the commission work attractive to the right men. The present difficulty, as I see it, lies in the fact that a temporary body (and the commissions are but temporary bodies) attempting to exercise judicial, legislative and executive functions—without precedent, without familiar methods of procedure, without practical experience in many of the matters to be regulated and with necessarily superficial hearings—cannot in fact distribute equity to all parties concerned; they are necessarily and because of their quasi-political character consciously or unconsciously prejudiced in favor of their constituents. To overcome this great impediment we must advance commissions as nearly as possible to the permanent status of a court, with the respect, honor and dignity that attach to a properly constituted judicial body. It therefore behooves every man with an ounce of patriotism to support the experiment that is now going on and co-operate toward its successful conclusion.

As we fertilize this state of public mind, we will approach equitable considerations of the rights of all concerned, and unless the rights of all concerned are treated equitably, any system of control and regulation is doomed to failure.

In fine, the question of control and regulation is on trial, and if it is not possible to elevate the commissions above the status of a partisan political body governed by other than the judicial consideration of the questions at issue, eliminating as far as is humanly possible popular clamor or the selfish demands of political or corporate interests, then we are doomed to failure, and government ownership and socialism will be our concomitants.

But proper regulation by properly constituted commissions will in the long run satisfy the public and the economics of the age by giving to the public all that is reasonable for it to have, leaving to private enterprise the exercise of initiative and opportunity for developments in the future.

MORE INDUCEMENT FOR THE ENGINEER

We shall some day, through the education and example of public service leadership, reach that state of public mind which is essential to all reform; then will there be an inducement for the well qualified engineer to take his place upon the public service commission. But the best work that the engineer can do to-day is to stimulate public consciousness to the necessity which is gripping us all that this great principle of public service control must succeed and can only succeed through the exercise of the qualities of fairness and broadmindedness of the American people.

The reasonableness of the authority which has been conferred upon governing commissions is to my mind a subject of serious importance. We are trained to the thought that there is a jurisprudence controlling our social and moral actions, but the management of a public service has not the advantage of such guidance. The law creates a commission which makes the rules, prosecutes under them, sits as judge and imposes the penalty. This is an anomaly which, in my judgment, is doing much to defeat the principle of reasonable regulation and control. Our prayer is: Give us a better public sentiment toward commissions, reasonable limitation of their functions, and the chance to exercise our enterprise and our patriotism.

What the Commissions Have Accomplished

By JAMES E. SAGUE

Commissioner, Public Service Commission of New York

IF we look back over the period of perhaps twenty-five years since the original Interstate Commerce Commission law was framed we will see that there has been great progress at least along two lines. First, in complete publicity of all railroad rates, and consequent stoppage of discrimination; and second, in the publicity of railroad accounts and the recording of the results of these accounts on the same basis, so that they can be properly compared and analyzed. I believe that the success of the Interstate Commerce Commission along these two lines would be a full justification for the creation and maintenance of the commission if nothing else had been accomplished, although we know that far more has been done in the settlement of controversies between shippers and the railroads.

This example has been followed by many of the State commissions. As a result the balance sheets and income accounts of the controlled companies are beginning to tell the truth. We all know that few balance sheets have told the truth in the past, and that the item "Cost of Property" has usually only represented the amount necessary to balance the liabilities and surplus, and often bore no close relation to the amount of money invested. It is also well known that some companies have shown a tendency to capitalize replacements regardless of the fact that the result is the padding of the income account. It is curious that many of the accounting examinations of the commissions have resulted in improving the companies' standing in rate cases, while at the same time the necessity of increased conservation in the payment of dividends has been indicated.

One of the main functions of the commissions has been to insist that corporations tell the truth about their affairs, their property, accounts and statements, and I think that this part of the work has on the whole been well done, and will prove of the greatest value, not only to the community but to the corporations themselves.

Need for Engineers to Show the Layman Their Worth

By JOHN W. LIEB, Jr.

Vice-President, New York Edison Company

TO handle the important economic, commercial and engineering problems and matters of public policy which may come before them requires a personnel in public service commissions far above the level of capacity of the ordinary office-seeking politician. It would be out of the question to obtain proper consideration for, safe judgment of and wise control over these important public and corporation questions from the average public-office incumbent. They require for their proper consideration, not only men of the highest personal integrity and ideals, but men of ability and capacity; minds capable of statistical analysis, with a judicial temperament, a wide knowledge of public affairs and business capacity, with a sufficient interest in the public service to devote the necessary time to the study of the immense mass of detail and complicated questions which come before the commissions for adjudication and decision.

It is an interesting study to consider the mental and personal equipment that is necessary in the ideal commission to exercise these extraordinary and important public functions. It is obvious that no single person could hope to possess the wide knowledge of public affairs, legal training, business experience, breadth of learning, and scientific knowledge necessary to cover individually and competently so vast and diversified a field. It is quite true that the commissions have their legal departments, accounting and statistical experts, engineering staff and specialists of various kinds in their organization, but the commissioners themselves must have ability of the highest order to digest the reports, briefs and statistics submitted for their consideration and to draw proper conclusions from the evidence and testimony, often contradictory and involved, of the expert witnesses which come before them in the hearings and investigations, and then to issue decrees and orders which, while in the public interest, shall be just and fair to the corporations.

TECHNICAL PROBLEMS TO BE SOLVED

It must be obvious that the presence of a technically educated and scientifically trained member on the commission should be of enormous assistance and value in its work, only second in importance to the presence of a representative of the legal profession. The professional politician is likely to be strongly represented in the make-up of the commissions, but to find a representative of the engineering profession in the commissioner's chair is unfortunately unusual and exceptional. This cannot be in the public interest and shows a state of things which may not reflect wisdom and foresight in the appointive or elective powers and is hardly creditable to the authority and influence of the engineering profession in public affairs.

It is a matter of common knowledge that our lawyer-made statutes and legal enactments are notoriously defective and inadequate, if not altogether ridiculous, when they undertake to cover technical matters in their provisions, and the burden often comes upon the commission to endeavor to interpret or carry out the provisions of an imperfect public service commissions law, under which they are appointed and which they are called upon to enforce.

What is true of the commission side of the table is largely true also of the other side, and the demand is for broader knowledge, more diversified experience and higher capabilities on the part of the executives, managers, and engineers of the corporations which come under commission control. Outside of questions of jurisdiction and the interpretation of statutory provisions it will be found that the usual questions which present themselves before regulating commissions are largely commercial, business and technical matters, the facts and data for which must be furnished by the commercial and engineering staffs of the corporations, even when they are actually laid before the commission by the representing attorneys.

ENGINEERS AS WITNESSES

Incidentally technical graduates should be trained so that when they are called upon to testify in these cases their presentation be clear, convincing, to the point and delivered with the weight of authority. We should cultivate the habit of clear statement as well as clear thinking, and school ourselves in the facility of communicating technical information and expert testimony so that it may be understood by the layman and that our arguments and presentation may create a favorable impression and carry due weight.

The consolidation of small plants into large production units to obtain the results of large bulk output, of lower investment costs, higher operating efficiencies, improved load factors and the advantages of combining diversity factors—all of these are questions in engineering economics and the efficient conduct of business which have developed new problems in the operations of public service corporations, and with these the commissions must concern themselves. If we are going to have effective supervision and strict regulation of utilities, the public must recognize the inherent monopolistic character of public utility service and protect the utility corporation against cut-throat competition and political conspiracy.

Unfortunately, much of the unsound economic doctrines, academic theories and socialistic tendencies with which the views of the public become inoculated and with which private corporations conducting public utility service have to contend emanate from the chairs of economics in our universities and colleges, and it is here that originate and spawn many of the doctrinaire pronouncements and irresponsible utterances which are so unsafe and unsound, but which nevertheless are sent out with the weight of authority of some of our great universities of learing.

ENGINEER AND PUBLIC QUESTIONS

The engineer, having had an important part in the progressive movements in our industrial expansion, should assume his proper share of the responsibility of helping to mold public opinion along right lines, and see to it that the public is furnished with correct and reliable information, for it is only through an enlightened public opinion that we can hope for justice and fair treatment. The progressive engineer should be a close student of public questions, of economics and political science; he should be in touch with the trend of public opinion and exert his influence and enlist his activities in counteracting so-called popular movements which are inimical to the public interest.

It is high time that the engineer and the engineering profession be accorded proper credit for the wonderful scientific and industrial accomplishments of the age which they have been instrumental in achieving and which have contributed so immensely to the happiness, comfort and progress of mankind.

Varying Air Pressure in London Tube Construction

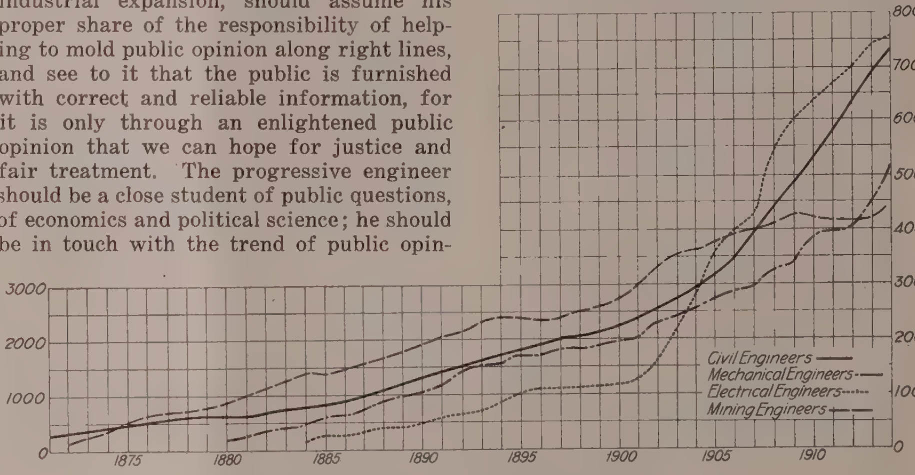
Range from 9 to 18 Pounds Per Square Inch Daily Demanded by Tide Levels

THREE underground railways intersect at Charing Cross, London, and the work of connecting them for the interchange of passengers is now being completed. About 180 ft. of one of the new tubes extend under the Thames. The peculiarity of this part of the work, which is effected by the usual shield plan, is that the clay cover is very thin, while there are considerable variations in the river level due to tide. It has been necessary to vary the air pressure daily during construction from 9 to 18 lb. per square inch. Had this precaution not been taken there might have been an excess of pressure at low tide, which would have lifted the river bed, whereas at high water, with too little pressure, there would be the danger of the river breaking in. The method adopted to insure that the right air pressure was maintained in the tunnel was to have a gage fixed in the river with marks corresponding to the air pressure which should be employed, and to regulate the pressure from observations of the gage readings. The arrangement has worked quite satisfactorily, it is reported, the tunnel being driven at the rate of 50 ft. per week.

Growth of the National Engineering Societies

Civil Engineers Rank Second to the Electricals, but Outnumber the Mechanical and Mining Men

THE growth of each of the four national engineering societies is shown in the diagram accompanying this article, taken from the "Journal" of the American Society of Mechanical Engineers. At the close of the year 1913 the membership of the American Society of Civil Engineers was 7272. It will be seen that the American Institute of Electrical Engineers leads by about 300, the great gain of that society from 1902 to 1905 and again in 1907 being unmatched by any similar performance of the civil engineers. The curve of the civil engineers seems to be smoother than that of any of the other three societies. It is also well above that of the mechanical engineers, who have in the last two years passed the mining engineers.



Growth Curves of the Four National Engineering Societies

THE OUTPUT OF PETROLEUM during each year of the century was more than maintained in 1913. The amount produced in the past twelve months exceeded 240,000,000 bbl., according to estimates. The production in 1912 was 222,113,218 bbl. The rate of increase in 1913 was greater at the end of the year than at the beginning. California increased at least 10,000,000 bbl. over 1912, almost reaching 100,000,000 bbl. The output of the Gulf field declined, but this was more than offset by the increase in northern Louisiana and Texas. Wyoming showed a significant increase.

Composition Flooring

Discussion by Manufacturers and Architects of Paper Presented by H. M. Hooker before Engineers' Society of Western Pennsylvania

THE necessity for an advance in standards of workmanship in manufacturing and laying composition flooring was generally agreed upon in the discussion which supplemented a paper read before the Engineers' Society of Western Pennsylvania by Mr. H. M. Hooker, district manager of the Marbleoid Company, of Pittsburgh. These comments, which are abstracted in the following article, will be of greater interest if compared with the summary of Mr. Hooker's paper in the Engineering Record of Dec. 6, 1913, page 635.

ABSTRACTS OF COMMENTS

Dr. R. R. Shively, of the Mallon Institute of Industrial Research, which has been engaged in studying and testing this flooring: Until recently an owner could not tell what kind of a composition floor he was going to get when he let his contract. Sometimes the floor would be absolutely perfect, and the next time a floor installed by the same company would have cracks and bulges and the color would fade. Upon investigating the conditions in the factories I found that there were very few scientific men connected with the work. The men that made up the mixture were ordinary laborers and they were never sure of having the same composition. In mixing the magnesium chloride the temperature is never taken into consideration in getting the percentage. In my experience they vary the percentage of magnesium chloride 5 to 8 per cent on different jobs. The chemical combination between the magnesium oxide and the magnesium chloride is one that must be controlled carefully, because an excess of magnesium chloride will cause an efflorescence. The magnesium chloride in excess has a tendency to decompose in the presence of moisture and liberate hydrochloric acid, and this acts upon the ferric oxide used as color and will lighten the shade of the floor.

VARIATION IN POROSITY

In the floors themselves the absorption is higher than has been indicated. I have found samples very hard, mainly sand and magnesium oxychloride with very little filler, in which the absorption was almost negligible, but I have found other samples in which the absorption would run as high as 12 or 14 per cent.

I remember a floor in a hospital in Brooklyn, under which were several furnaces of the heating department. It cracked in every conceivable way. If the man that put in that floor had put in a material to allow for more expansion and contraction, he could have overcome the cracking. But it is almost impossible, using inorganic coloring matter, to get a floor that will withstand chemical changes. I tried very hard to incorporate some analine colors, but they will not withstand the reactions of the alkali.

Composition is the most sanitary floor on the market, without a doubt, and its low conductivity of heat makes it ideal for schools and hospitals. The effect of oil is a thing that is not thoroughly understood. The addition of oil to ordinary cement is supposed to injure the cement. The action of the lime in the cement combining with the organic acid of the oil has a tendency to cause the cement to disintegrate. My experience has been that this composition is benefited by oil, especially by a vegetable oil. It seems that the magnesium salt of the organic acid has a tendency to render it more nearly waterproof. There is a coating of soap that surrounds each particle and prevents the absorption of water.

Samuel Jaros, President, General Kompolite Company, New York: Many of the faults under which manufacturers are laboring are due to the improper foundations upon which one is compelled to lay the floor. The cement foundation may be placed improperly. If it is poor it will absorb the chloride and leave the material soft. If it is too hard it will furnish too much resistance for the contraction and expansion in the mass. Consequently the manufacturer is compelled to gage his material according to the conditions under which he is forced to act, and very much of the trouble we are confronted with is due to this one fault. This is one thing which the architect and engineer should specify very carefully so that the danger may be minimized.

CAUTION NECESSARY IN SPECIFYING

R. W. Page, President of the Marbleoid Company: When we take into consideration the fact that the oxychloride cement used in all composition flooring is capable of carrying other ingredients up to twenty times the weight of the cement we can readily see what a vast variation there may be, not only with respect to the number of ingredients added but also in the relative properties secured. It is very likely that no two floorings of different manufacturers are essentially alike. For these reasons the careful architect or engineer will not specify merely "composition flooring." Under no circumstances will he make his selection solely from samples submitted. All samples look very much alike. Often the impractical mixture will make up into a better looking sample than the efficient material for the simple reason it is often easier to trowel-finish such a mixture to a good, even surface.

Wood foundation presents no great difficulty. The concrete foundation must be of sufficient richness, and under no consideration should it contain lime. Buckling or coming away from foundation is almost always due to one of these causes.

Composition flooring requires radically different handling and troweling from that given Portland or other cements. It is utterly impossible to take a workman inexperienced in the work of this material, from either a cement workers' union or a plasterers' union, and expect him to turn out a satisfactory piece of work. Expert workmanship is of the greatest importance owing to the fact that the color appearance of the finished flooring is dependent largely upon the time and manner of the final troweling.

Owing to the liability of damage from other mechanics (composition flooring is far more liable to such damage when it has been newly installed than will be the case after it has reached its maximum hardness) this material should be practically the last thing installed in a building.

Frequent washing and an occasional oiling will serve to keep a floor in perfect condition, and with this care it has been repeatedly demonstrated that composition flooring improves in appearance as it ages under service.

SANITARY VALUE

R. M. Trimble, Architect, of Pittsburgh: I do not consider the use of a composition floor on wood to be advisable, unless some method is discovered which will eliminate the hollow sound occasioned by walking over a floor so laid. Another objection I find is the efflorescence which appears sometimes on the surface of the floors, an objection applying particularly to residence work.

Composition floors are satisfactory for use in hospitals, offices, schools, in the service portions of residences, and in places of like character, where its sanitary characteristics make it valuable. The success of the floor seems to be dependent upon conditions which are hard to control; upon the weather, which if too hot causes the material to set before it can be properly worked, or upon the concrete underbody, which should be seasoned for weeks before the composition floor is applied.

Howard C. Frank, Architect, of Pittsburgh: Composition flooring, lacking the "absorbers" possessed by its competitors (by reason of its having a considerable polish and being in continuous mass), leaves something to be desired in the matter of plane, having the slight undulation resulting from hand-troweled material. I have wondered whether the solution is to add another 1/32 in. or 1/16 in. to the top coating and having floated it down to an approximate plane and allowed it to set, grind it to a positive plane with a mechanical wood-floor finishing machine provided with emery cloth disks instead of sand paper, and follow this with a similar mechanical buffing or polishing device, even though the cost were increased 1 or 2 cents per square foot.

CARE IN MAINTAINING

F. R. Muller, President, Franklyn R. Muller & Company, of Waukegan, Ill.: The composition should consist of a good per cent of the best grade of calcined Grecian magnesite, which must be thoroughly mixed with other ingredients so that when used in a floor it will be soft enough to withstand abrasion from the tread, yet not hard enough to crack under even pressure.

A composition floor should have approximately the same care that a hard-wood floor receives. Where it is in heavy use it should receive a coat of linseed oil with one-third benzine as a dryer lightly applied at least once every six weeks. It should also receive an occasional coat of liquid wax. This keeps the composition with a bright, clear surface and prevents dust and dirt from working into the surface. A composition floor does not give good results in shower baths, or in places where it is continuously subjected to moisture. The continuous moisture causes the salt and chloride to redissolve and will leave the remainder of the ingredients in a free state that only occurs where the application of water is constant.

William von Baumbach, President, The American Monolith Company, of Milwaukee, Wis.: The chemical consistency of the finished product depends upon using the correct proportions of oxide and chloride of magnesia, and also the percentage of filling materials, such as asbestos, silica, wood fiber or other substances. The University of Wisconsin, at my suggestion, has been taking up this subject in the engineering department. I have submitted to the university all of the data gathered during 14 years' experience in this business, and it is making an exhaustive series of tests of composition flooring material. The object of these tests is to establish what shall be the chemical consistency of the best composition flooring material; what filling materials will combine with the oxychloride cement; and what combination of oxychloride cement and filling materials form the strongest and most durable finished product.

The Bureau of Standards at Washington has tested composition flooring, but has done so without reference to its chemical consistency, simply testing samples produced by different manufacturers. The only tests which will ever prove of value are those based on the chemical consistency of the article tested.

C. L. Wooldridge, Superintendent of School Buildings of Pittsburgh: The comparative tables which Mr. Hooker has shown are all based on a high grade of composition flooring. Many of the floors which have been laid, and will be laid, would not rank so high in the lists because the contractors have experimented at the expense of their clients. I do not believe there are more than half a dozen companies in the country who are really qualified to manufacture and install composition flooring equal to the ones referred to in the author's comparative lists.

A. Fellheimer, Architect, of New York: The following letter received from Mr. Paul Smith, superintendent of the New York, Westchester & Boston Railway Company, is self-explanatory: "A year ago I formed a poor opinion of composition flooring when it was new in our stations, due to the fact that some of the composition was working out on the surface, and the floors did not look very good and were hard to maintain; but for some months past they have been very satisfactory, and I believe that it is an ideal floor to have in an office building.

"We use an oil soap for scrubbing the floors; they are very clean and the scrubbing can be done often, as the floor does not retain the moisture, and I think they are a decided improvement over wooden floors. We use a soft broom for cleaning, which eliminates the dust feature that we get from a straw broom when sweeping a wooden floor.

"We have had some complaints, also, from our clients, due to shocks obtained while using the telephone and standing on the composition flooring. I personally experienced this same trouble."

Mr. Hooker closed the discussion of his article. He said: "Practically all of the criticism passed is comprehended in the simple tabulation below.

"Mr. Trimble's criticism of the hollow sound over a wood foundation is well taken when applied to the single coat floor, the type first used. The great advantages of an under and more fibrous coat were later discovered, and now the under coat is universally used by the best manufacturers. This does, or should if properly installed, completely do away with the hollow sound and gives a floor that is much quieter than wood, concrete, tile, terrazzo, or marble.

"Regarding Mr. Frank's suggestion that the surface be planed, or ground, down to a plane, as is done in the case of terrazzo and wood flooring, the idea of getting a perfect plane is fine. His idea has been repeatedly tried out and was hailed in Germany as a means of avoiding the necessity of expert troweling. Up to date, however, the floors so constructed are more porous and do not stand up under use as well as the expertly troweled surface. When properly troweled the surface can be brought to a very even plane. It is only poor and somewhat inexpert troweling that gives an objectionable surface which reflects the light unevenly."

Tabulation of Criticisms of Composition Flooring and Suggested Remedies

Criticism	Cause of Trouble	Remedy
Efflorescence.	Excess or impure magnesium chloride. Temporary only.	Skill on job, at factory and management.
Fading.	Excess magnesium chloride or improper coloring matter.	Skill on job, at factory and in management.
Hollow sound over wood foundation.	Occurs with one-coat floor.	Skill in management.
Special advance precautions.	Improper foundation.	Skill in management.
Uneven plane to finished surface.	Improper leveling and trowelling.	Skill on job.

Caliche Roads Near Phoenix

Calcareous Foundation Surfaced with Sand and Road Oil at Cost of $5,000 Per Mile

MANY miles of country roads have been improved in the southwestern country by the application of caliche, which, if properly handled, gives satisfaction for a country road of moderate cost. Last season 3 miles of road near Phoenix were improved by the application of caliche and a wearing surface of oiled sand and gravel.

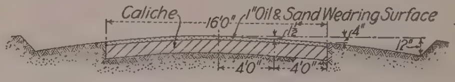
Caliche is a local name for a calcareous cement-like deposit which occurs in great abundance in many parts of Arizona, particularly in and near the foothills. When pulverized, wet and compacted by traffic or rolling it forms a macadam or concrete-like mass of moderate hardness and fairly high degree of toughness. One of the difficulties near Phoenix has been to get the material spread evenly enough to insure a uniform surface under traffic. As it comes from the quarries a small portion is pulverized, but much of it is in lumps 1 ft. in diameter in which small boulders are embedded. The latter, if not excluded, make the road lumpy.

Three miles of the McDowell road, 2 miles from Phoenix, were constructed under rigid specifications calling for the elimination of stones 3 in. thick and 5 in. long. The roadway is 16 ft. wide and covered with 5 in. of caliche with a 1-in. wearing surface of oiled sand and gravel. Large lumps were broken with a sledge hammer and the loads spread evenly. The subgrade was first made compact by plowing to a depth of 6 in. Water was obtained from irrigation ditches by a portable 2-in. American centrifugal pump driven by a gasoline engine. A continuous border was left on each side of the road to retain the water, which was applied in sufficient quantities to dampen the soil to a depth of 1 ft. After the surface had dried to a non-sticking consistency it was compacted by a 10-ton Kelly roller in sections not to exceed $\frac{1}{2}$ mile long.

Portable Pump Outfit

The material was dumped in ridges parallel to the center line of the road. After spreading and wetting it was rolled and then covered with a top dressing of sand and road oil containing 80 per cent of asphalt. Oil was applied at the rate of $\frac{1}{2}$ gal. per square yard and enough sand spread on to take up all free oil. After rolling the road was treated with a second application of the same amounts, bringing the wearing surface to a thickness of about 1 in.

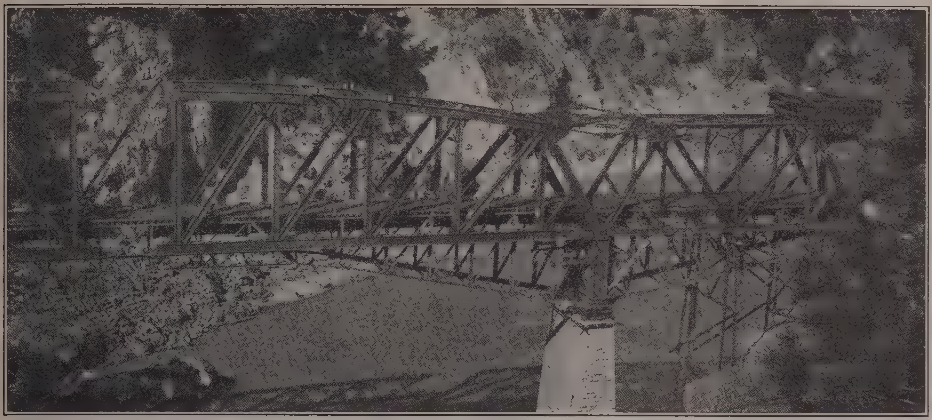
The engineer states that it made a very satisfactory surface, but it remains to be seen whether the sand and oil will last as long as the caliche base. He is also of the opinion that an improvement can be effected by crushing the caliche and the stone before using, so as to insure obtaining a smooth surface. Ruts and chuck holes in caliche are easily repaired by picking out the defective spots to a depth of 3 to 4 in. and filling the holes with fresh material, thoroughly wet and rammed.



Cross-Section of Caliche Road

The cost of this road was about $5,000 per mile. Caliche was hauled from $1\frac{3}{4}$ to $4\frac{3}{4}$ miles and the oil from $4\frac{1}{2}$ to $7\frac{1}{2}$ miles. The improvements were carried out by the Good Road Company, of Phoenix, for the Special Road District 2 of Maricopa County under the direction of Mr. C. O. Thompson, engineer.

Improvised Derrick Cars were recently used in the erection of moderate-span single-track deck plate-girder bridges in New Mexico. Each of two ordinary flat cars was provided with a timber tower about 10 ft. high, built over the truck at one end and slightly overhanging the car. Tackles were suspended from these towers, and the latter, being brought up to opposite ends of the completed span, lifted it clear and carried it between them across the falsework to the required position on the line. The falsework was then dropped down, giving clearance for the span to be lowered to permanent position, and the track restored to service with a very short interruption of traffic. The construction of the temporary towers on the flat cars cost less than $200, thus making an economical arrangement which might easily be available under conditions where the services of derrick cars could not be advantageously secured.



End Spans Completely Erected and Center Spans Nearly Erected

Replacing a Three-Span Cantilever Bridge by Independent Span

Falsework Eliminated by Supporting the New End Spans from the Old Ones and Erecting the Center Span by the Cantilever Method

ELIMINATION of falsework was the construction feature in replacing an old 315-ft. bridge span over the Fraser River on the line of the Canadian Pacific Railway, 150 miles east of Vancouver, B. C.

The end spans were supported during erection on the old structure and afterward served as anchor spans to counterbalance the main span during its cantilever erection. Erection adjustments of the center panel were made by screw toggles.

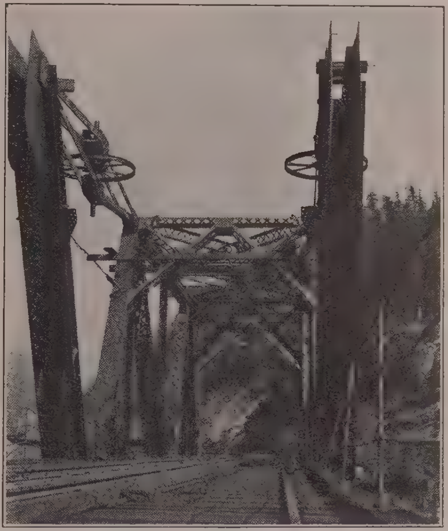
The railway follows up the north bank of the river until the canyon swings around toward the north to such an extent that a crossing becomes necessary. The bridge site selected by the locating engineer in 1883 has proved to be well adapted for a crossing, as it is one of the narrowest places on the river and has the advantages of giving a good alignment and solid rock foundations.

The original cantilever bridge, shown in one of the photographs, was erected in 1883-84, the piers being placed close to shore, giving a main span of 315 ft. This location of the piers made it possible to use anchor spans 105 ft. in length, running from the piers to stone abutments, and two cantilever arms and a suspended span—all three of which being 105 ft. long. Thus the bridge had a total length of 525 ft. between abutments. The structure has been in constant use from the day of its completion in 1884 until 1910, when the use of heavier engines and rolling stock made a change necessary.

The old site was considered the most suitable for the location of the new bridge, and it was decided to erect here three through trusses, using the same masonry, with some slight additions, which supported the old bridge. The two short end spans were erected first, using the anchor arms of the cantilever as falsework. The 315-ft. through span was then erected by weighting down the short spans (specially designed for this stress) with old rails and connecting the top chords of adjacent spans by means of a temporary toggle joint which linked up the steelwork so as to employ the cantilever principle during erection.

Four toggle joints were required, each consisting of eight 1½ x 6-in. eyebars connected to steel pins in the end posts and at the center, as shown in one of the illustrations. Four pins were used at the center, each pair being carried in a frame in which was fastened a nut engaging a thread on a vertical shaft operated by a bull-wheel. By turning this wheel the angle of the toggle joint could be changed at will and the span under construction lowered gradually into place from both ends until the two parts met in the center and were coupled up. The maximum weight of rails put on each short span was about 400 tons.

During the course of erection the traffic averaged from eight to ten trains per day, and was maintained without any delays. After the new bridge was completed and ready for service the old bridge was taken out, piece by piece, and utilized on the Esquimalt & Nanaimo Railway, a Vancouver Island branch of the Canadian Pacific Railway, on which lighter rolling stock is used. The piers which were used for both the old and new bridges over the Fraser River are about 82 ft. high and are founded on solid rock exposed on the shores of the stream.



Toggle Joint Anchoring Spans

The difference between low and flood level of the river under the bridge is 67 ft., the lowest water record being 125 ft. and the flood 58 ft. below the deck.

The cost of the original bridge, including masonry and steel, was approximately $270,000, and the cost of replacing the steelwork is estimated at $160,000. The new bridge was fabricated by the Canadian Bridge Company according to designs prepared by Mr. C. N. Monsarrat, engineer of bridges for the Canadian Pacific Railway. Mr. C. E. Cartwright was division engineer, succeeded by Mr. H. Rindal, and Mr. H. B. Walkem, resident engineer, was succeeded by Mr. F. P. Wilson.

New Superstructure after Removal of Old Spans

Old Bridge before Erection of New Superstructure

Factory Lighting

Discussion of Correct and Incorrect Methods and of the Advantages of Proper Illumination of Industrial Plants

Waste of time, increased danger and injury to the workmen's eyesight—these are said to result from poor lighting in factories. Poor and good lighting have for some time been under investigation by the Illuminating Engineering Society. The society presented various phases of the matter at the recent International Exposition of Safety and Sanitation in New York City, and the vice-president of the society, Mr. G. H. Stickney, read a paper on the subject before the Safety and Sanitation Conference. The following notes are taken from his paper.

The economic value of good illumination, aside from accident prevention, is evident in the greater facility with which an employee can work under good illumination and the greater accuracy with which gages can be read and tools can be set. One large manufacturer, on investigating his lighting conditions, found certain departments in which the operatives were practically idle for about an hour a day during the winter months, solely on account of darkness. Good artificial illumination can be furnished in such a factory for eight hours a day at a cost equivalent to about five minutes of the time of the workmen benefited. This illustrates the extravagance of poor lighting. For a great variety of conditions good illumination reduces the manufacturing cost by increasing production, raising the quality of workmanship and reducing the number of defective parts and "seconds."

Accident Prevention

The phase of accident prevention is illustrated in the case of the foundry or other shop where cranes or other powerful machinery are in operation. The likelihood of crane and elevator accidents is greatly reduced with proper lighting. In the foundries and yards of a plant it is practically impossible to eliminate irregularities under foot. If not illuminated, these may readily cause falls, with resulting injuries; and in foundries where molten metal is carried and hot metal abounds they may often cause serious burns. Even though guarded to the fullest extent, powerful machinery presents a menace unless the operatives are given an opportunity to see and thus avoid the danger points.

As to the preservation of the eyesight, there are many manufacturing operations which cannot be carried on without accurate visual inspection. Some of these produce considerable strain even under good illumination, and to require their performance under poor illumination is certain to result in more or less rapid impairment of vision.

Undoubtedly a higher intensity of illumination is needed in most workrooms, but there are other features of equal and sometimes greater importance. The minimum intensity acceptable generally depends upon the reflecting power of the surfaces to be seen, the fineness of the detail to be observed, the time of observation and the closeness of application. Unless glare be introduced, a higher intensity of light is rarely objectionable, except from the standpoint of cost. The gain secured by the increase of intensity is not proportional to the intensity, and there is a point beyond which the gain would not warrant the additional cost.

The most common defect in lighting is excessive glare and absence of diffusion. Glare may emanate directly from the light source or be reflected to the eye by a glossy surface; it can also be caused wherever excessive contrast of intensity appears in adjacent fields of vision. The dazzling effect is unpleasant and interferes with seeing. Under continued exposure eyestrain and even permanent injury to the eye may result. An unshielded light hung over a machine is a common source of eye fatigue. The glare may not be so evident on first glance, but when the workman's eyes have been subjected to such light for a long time discomfort and inability to see result.

Use of Reflectors

The workman frequently complains of insufficient light when in reality the intensity may be higher than is required for the work. In case an attempt is made to correct this by installing a larger light, the workman's eyes are subjected to a still more severe strain. The proper correction should be to shield the light by means of a proper reflector. As such a reflector would tend to direct more of the light upon the work, the working intensity would be increased; hence in many cases it may be possible to reduce the size of the lamp, or relocate it so as to enlarge the area illuminated.

When a light cannot be removed entirely from the field of vision its brilliancy should be reduced by means of a diffusing globe or reflector so as to increase the apparent size of the light source and reduce the contrast between it and the background and the sharpness of shadows in the illumination.

Glare received from specular reflection of glazed paper, desk tops or polished metal often induces eye trouble, headache, and other indispositions, though the sufferers may not be aware of the cause. The remedy is to change the relative positions so that the reflected light is kept out of the eyes as much as possible and to enlarge the dimensions of the light source.

Proper Distribution

Another defect commonly found in industrial lighting is improper distribution. This may be due to too wide a spacing of lighting units. Under this condition some parts of the room are insufficiently lighted, while other parts may have more light than is necessary.

Improper direction of light may illuminate the wrong side of the machine, leaving the important parts in shadow. If the bright parts are near the shaded ones, whatever illumination may fall upon the shaded portion is rendered less effective by contrast.

Unsteady or flickering illumination is always objectionable. Such variation should always be avoided, whether caused by the units themselves or by the light passing through such things as moving wheels.

Good illumination cannot be prescribed without knowledge of the use to which it is to be put. In order properly to plan the lighting of a factory one should be familiar with the processes employed, the arrangement of machinery and work tables and the quality of product manufactured. Experience gained in well-lighted factories should be utilized in planning lighting installations.

Noise of Brick Pavements

Comments by R. Keith Compton on Experience of Baltimore Paving Commission

Following the appearance of the editorial on "Hard and Soft Fillers" in the Engineering Record of Dec. 20, 1913, page 680, a correspondent, commenting upon the view there advanced that the noise of a brick pavement is due to the rattle of the wheels over the unfilled joints rather than to the impact of the horses' hoofs, called attention to the comparative noiselessness of brick pavement on a hospital street in Baltimore. An inquiry was therefore directed to Mr. R. Keith Compton, chairman of the Baltimore Paving Commission. The following reply, in which Mr. Compton comments also on the commission's practice as to kind and depth of cushion, has been received:

"I laid a Hillside brick pavement on Saratoga Street, which is on an 11 per cent grade, on the side of the city hospital. With this grade, of course, there is not much traffic, although I understand that after laying this pavement the noise has been considerably reduced. Being on such a heavy grade, the blocks were not rolled, but thoroughly tamped on a rolled 1½-in. cushion.

Wire-Cut Vitrified Blocks

"We also laid in the rear of this hospital wire-cut vitrified blocks in what is known as Hargrove alley. While there is not much through traffic in this alley, there is considerable hauling of coal and other material. It is an unusually smooth job, and the hospital authorities inform me that the noise has been considerably reduced. These blocks were thoroughly rolled on a firm 1½-in. cushion.

"Your theory that most of the noise on a brick pavement comes from the rattle of the wheels over uneven and unfilled joints is undoubtedly correct, although so constructing your pavement that it will rest firmly on a firm cushion also reduces the noise and will do away to a very large extent with the rumbling sound so often noticed in connection with cement-filled pavements. One factor is about as important as the other, and neglect in the details of construction in either one will, in my judgment, give you trouble.

Cushion

"Our specifications first called for a 2-in. cushion. We found it very difficult, however, to thoroughly compress a 2-in. cushion, and I changed my specifications, calling for 1½-in. maximum cushion. The concrete is so uniform that we come very close to the 1½-in. average throughout. I believe now that it is a quite common policy to call for a cushion not over 1½ in., and indeed if I could depend on a uniform base I would still further reduce the cushion to an inch. I am also advocating in this cushion loam to the extent of 15 per cent, as it is much more easily and thoroughly compressed than if absolutely clean sand is used.

"To be perfectly candid, I hardly think that either one of the streets mentioned is a suitable basis for argument, as there is hardly enough traffic to justify any real conclusions. We have laid a great many miles of brick streets, and while I have noticed that some of them are quite noisy, others are not so much so, yet not one complaint has reached this office from any property owner, tenant, or others interested."

Making Long Fill from Trestle across Minnesota River Valley

Ortonville-Milbank Alignment Revision

Long Fill and Interesting Reinforced-Concrete Work on Improvement of the Chicago, Milwaukee & St. Paul

By F. W. VAN BUSKIRK

Assistant Engineer, Chicago, Milwaukee & St. Paul Railway, Aberdeen, South Dakota

An interesting portion of the double-tracking and rectification of grade and alignment which the Chicago, Milwaukee & St. Paul Railway now has under construction between Minneapolis and Aberdeen, S. Dak., is the line from the east end of the yards at Ortonville, Minn., to Milbank, S. Dak., a distance of 11.3 miles, of which 9.85 miles are new double-track construction entirely separated from the old track and right-of-way. This work comprises one of the heaviest sections on the division and one of the most radical changes.

REDUCING GRADES AND CURVES

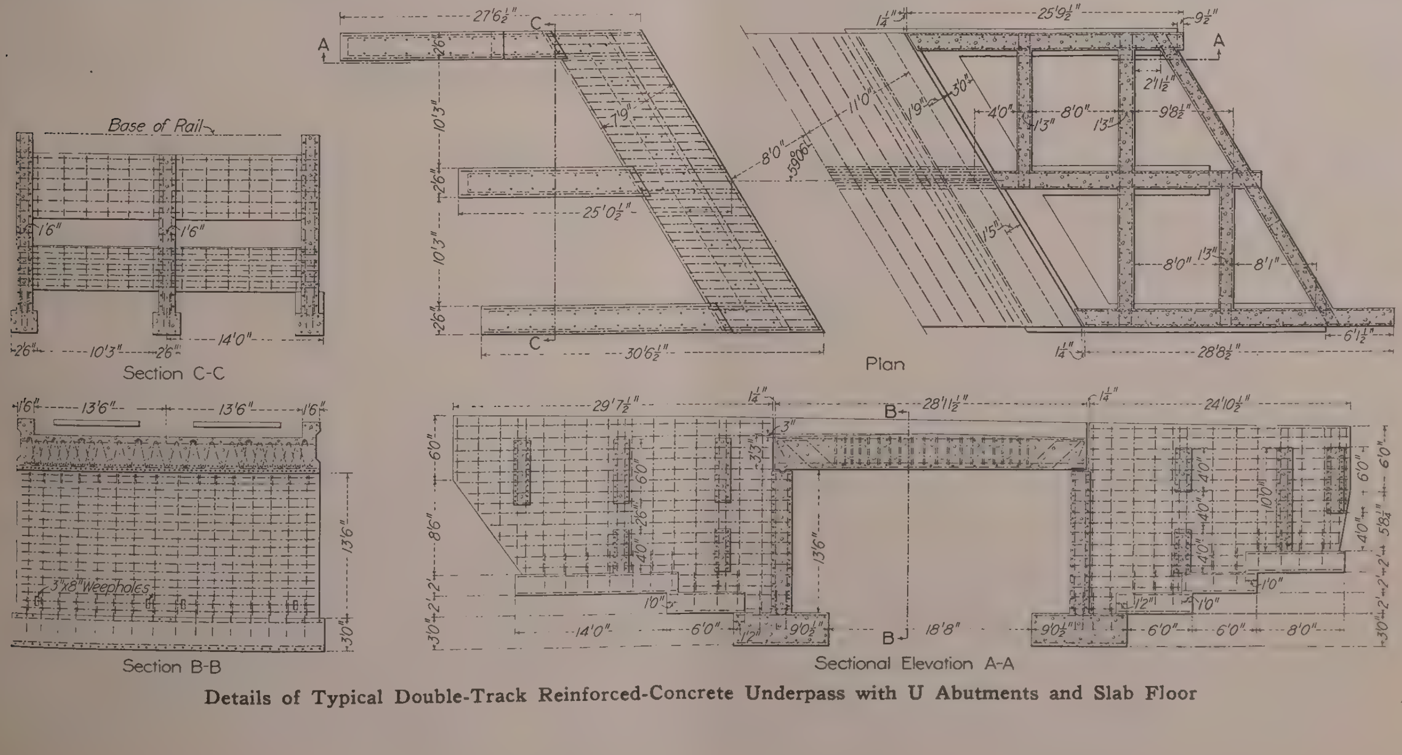
When the original railroad was built it was carried into Ortonville from the east to the State line at the foot of Big Stone Lake, but owing to some difficulty the line was not extended from the State line west. Instead of this it branched off to the south from the point known as Junction Switch, about 1½ miles east of Ortonville. This left a stub-end track for Ortonville, requiring trains to head in and back out, or vice versa. This arrangement will be done away with by the change of line. Furthermore, the ruling grade of 1 per cent will be reduced to 0.5 per cent, and numerous curves with a maximum sharpness of 3 deg. will be eliminated, the new line having only two curves—a 1 deg. 26-min. and a 1-deg. curve. The new alignment will be as nearly an air line as practicable without introducing more curvature in Milbank yard, which was not deemed feasible.

Previous to making a decision on the final location of the new line a number of reconnaissance, preliminary and location surveys were made with comparative estimates of cost, having in mind the future benefits derivable from each of the various propositions. It was known that it would be impossible to conform closely to the old alignment and at the same time secure the desired minimum curvature and grade. It was further desired to secure better terminal facilities, Ortonville being a summer resort, reached only by the St. Paul. At present Ortonville and Big Stone City have separate stations, in each case at some distance from the town. It has been proposed to build one station on the State line for the joint use of the two towns, although it is not yet decided whether to build one station or two. If the single-station proposition is approved the new station will be located on or adjacent to the Minnesota and South Dakota State line, on the new line, near the south end of the lake, and will be on a 25-ft. fill, accessible to both Ortonville and Big Stone City by means of a new lakefront drive and approaches which are to be constructed for the use of the public.

As previously stated, the new alignment will be built with a maximum curvature of 1 deg. 26 min. and a maximum grade of 0.5 per cent. It will be 1090 ft. longer than the old, but will eliminate 161 deg. 16 min. of curvature. It passes through the residence district of Big Stone City in a 40-ft. cut. The right-of-way is expensive, including about 200 town lots, eighteen houses and a church. This property, however, is being purchased without any unusual trouble on account of the very friendly attitude of the people, who are looking forward to the operation of the new road to their advantage.

GRADING

The grading contract was let in December, 1912, to Morris, Shepard & Dougherty, contractors, of St. Paul, Minn., who have their equipment installed and are making good progress with the work. The large fill across the Minnesota River bottom, east of Big Stone, 6600 ft. in length, involving approximately 550,000 cu. yd. of material, is being made by dumping from a trestle across the entire distance material hauled from Big Stone by construction trains. The same method is being used where the embankment across the Whetstone Valley, west

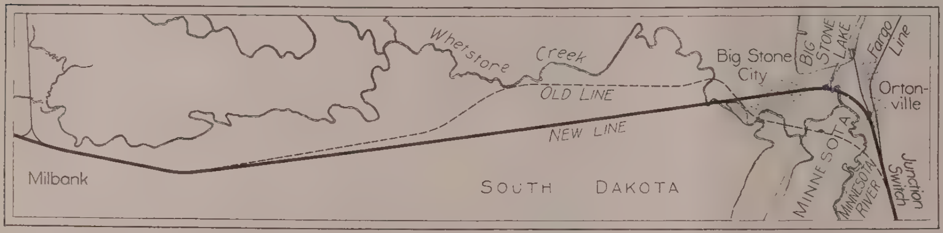


Details of Typical Double-Track Reinforced-Concrete Underpass with U Abutments and Slab Floor

of Big Stone, is being built. In the 11.3 miles there will be approximately 1,040,000 cu. yd. of material to move, most of which will be steam-shovel work.

On the ten concrete bridges to be built there will be four undergrade highway crossings, three overhead highway crossings, three 50-ft. reinforced-concrete arch spans over the Minnesota River and one double 60-ft. reinforced-concrete arch over the Whetstone Creek, requiring about 7800 cu. yd. of concrete. In addition to this there will be needed approximately 200 tons of concrete culvert pipe for waterways. Details of one of the highway undercrossings are shown.

The engine house will be remodeled and other general increased terminal facilities will be constructed at Ortonville, including many track changes, the plans of which are now being worked out. In connection with this a scheme will be perfected whereby the traffic from the Ortonville-Fargo branch from the north will reach the new station site with the least amount of delay.



General Map of Old and New Lines from Ortonville to Milbank

Mr. H. A. LaRoy, resident engineer, is in charge of the work, reporting to Mr. T. H. Strate, construction engineer, at Aberdeen, S. Dak.

Investigation of Sanitary District Hydroelectric Plant

INVOLVED in the rate controversy between the Sanitary District of Chicago and the city, noted in these columns Dec. 13, 1913, is the question of whether the peak load occasioned by the overlapping of the commercial and city business might embarrass delivery of current to the city. Mr. E. B. Ellicott, electrical engineer of the district, has said that a $50,000 steam auxiliary will remove any prospective embarrassment, while Mr. Ray Palmer holds that the commercial load will have to be cut off in order to deliver the contracted load. In view of these opinions the trustees of the Sanitary District have ordered an investigation on the following points:

1. Present condition of the hydroelectric plant and equipment and the transmission system, including city substations.
2. Present efficiency of operation.
3. Condition and efficiency of the auxiliary steam plants.
4. Effect of peak load on delivery of current to the city under the present contract and conditions, in event of the addition of 1000 more lamps; in the event of the United States permitting a flow of 10,000 cu. ft. of water per second, in the event of the United States restricting the flow to 7500 cu. ft. of water per second.

WOODEN PILES 140 FEET LONG are not uncommon in Oregon. Mr. F. W. Moore, bridge engineer, of Portland, has stated that 110-ft. piles were driven recently in the falsework for the Newberg Bridge over the Willamette River.

Relation of Bleach Application to Typhoid Rates

THAT bleach treatment of drinking water, to be effective, must be sufficient to control the periods of greatest infection is a principle laid down by Messrs. W. P. Ellis and R. G. Perkins in an article in the December, 1913, monthly bulletin of the Ohio State Board of Health. Charts and records of typhoid mortality and incidence, bacterial results, rainfall and wind at Cleveland, Ohio, are presented for 1912 to substantiate their contention that the water supply did not receive enough hypochlorite to keep down the typhoid rates.

BLEACH TREATMENT

When treatment with bleach was started in September, 1911, an amount equivalent to 0.7 part per million was recommended and added until February, 1912, when the quantity was reduced to 0.4 part per million. Following this reduction, according to the article, there was a steady rise of typhoid, indicating a progressive increase of pollutions of the water in the river, with consequent rise of pollutions at the intake. The floods of 1913, with the resulting turbidity and typhoid epidemic, prove, so the authors claim, that investigators were in error when they stated that pollution could not pass a 2-mile limit. The rise in rate has continued up to September, 1913, until conditions were not much different from those existing before the beginning of the treatment of the water.

USE OF CHLORINE

The original contention that unless an amount equivalent to 0.7 part per million of actually available chlorine was used in the treatment the results would be unsatisfactory appears to be borne out by the chart, and is further confirmed in a general manner by the findings in other cities where an amount equal to or greater than this has been found essential for successful disinfection. A weak dosage cares only for those periods in which the water actually coming in contact with the disinfectant is weak in bacteria and organic matter, and the results of laboratory tests show that the variation in the quality of the water may be almost hourly in character.

A RAILROAD BRIDGE 2 MILES LONG to link the island of Rügen in the Baltic Sea with the German mainland is being considered. The success of a 50-mile train ferry between Sassnitz, a northern point of Rügen, and Trelleborg, in Sweden, together with the growing popularity of the island as a holiday resort, has resulted in a passenger traffic that almost reached 100,000 in 1912. The proposed bridge would greatly shorten the journeys between many German cities and Stockholm and Christiania on the Scandinavian peninsula.

Sydney Harbor Bridge

Steel Cantilever Structure, 2600 Feet Long, to Cost $13,750,000

SEVEN plans varying in estimated cost from $800,000 to $35,000,000 have been proposed for the long bridge from Dawes Point to Milson Point in Sydney Harbor, New South Wales, and one at an estimated cost of about $13,750,000 has been adopted. It provides for a structure 2600 ft. long between centers of anchorage piers and includes two 500-ft. anchor spans, two 520-ft. cantilever arms and a 550-ft. center span. The main span has a maximum clearance of 170 ft. above the water and a minimum clearance of 156 ft.

TRUSSES

The trusses, 94½ ft. apart on centers, are 270 ft. deep at the main pier and 100 ft. deep for the entire length of the center span. The bottom chord is horizontal and the top chords are curved in circular and parabolic arcs. The main pier bearings are of cast steel on pyramids of I-beams and concrete distributing the load on the masonry. The trusses have eyebar tension members, except in the center span, where they are riveted to provide for cantilever erection. They are mainly of nickel steel, the floor system being constructed of carbon steel.

The bridge has a single deck with a total width of about 140 ft. at bottom-chord level. There are four railroad tracks and one 35-ft. roadway between the trusses and one cantilever footway 15 ft. wide and one cantilever motor roadway 18 ft. wide outside the trusses.

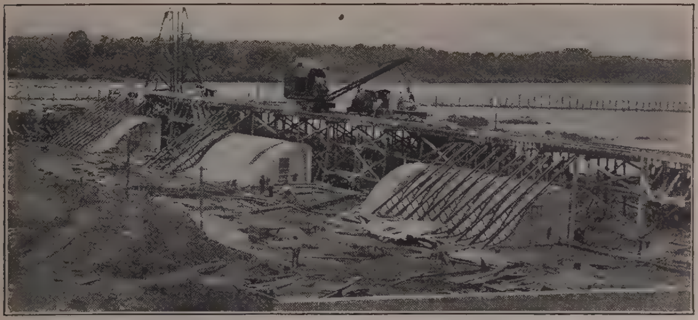
TRAIN LOAD

The bridge is designed for a train load consisting of a 65-ft. 160-ton electric locomotive and 550 ft. of cars weighing 2000 lb. per foot on each of two tracks and for the same locomotive, and 500 ft. of a 2240-lb. train on the other two tracks. The main roadway is proportioned for a uniform load of 100 lb. per square foot plus a concentrated load of 8 tons on one axle and 16 tons on another axle 12½ ft. distant. The motor roadway is proportioned for a uniformly distributed load of 80 lb. per square foot for trusses and 100 lb. per square foot and concentrated loads of 7½ tons on the floor system. The footway is proportioned for a load of 100 lb. per square foot.

Smoke Abatement in Chicago

INSTALLATION of a gas washer for the smoke from the Lake Shore roundhouse and introduction of buckwheat anthracite fuel for use on the Chicago River tugs are two striking advancements made in Chicago in 1913 to abate the smoke nuisance, according to Mr. Osborn Monnett, smoke inspector. Smoke and gases from thirty-two roundhouse jacks are passed through a tank of water, removing all the carbon and solid matter.

The new Erie Railroad tug, which is said to be the largest on the river used for towing its line of steamers and transfer barges, uses anthracite, and other boats have found it feasible by the installation of proper grate bars and a forced-draft apparatus. The result, Mr. Monnett asserts, is an absolutely clean slack and a distinct saving in the cost of operation.



Steel Rib Forms for Dam with Pile Foundation

Steel Ribs Reversed for Retaining-Wall Forms

Coon Rapids Hydroelectric Development

Another Low-Head, Single-Runner Hydroelectric Plant on the Mississippi River—Absence of Bedrock Demanded Unusual Features of Design and Methods of Construction

CONSTRUCTION of the Coon Rapids hydroelectric plant on the Mississippi River, 13 miles above Minneapolis, Minn., was more than 60 per cent complete on Oct. 1. The electrical energy generated at this point will be used in conjunction with the Taylor's Falls plant, the development at St. Anthony Falls and auxiliary steam plants to supply the rapidly increasing power demands of the Minneapolis General Electric Company.

For the present the rated capacity will be 10,500 hp, made up of five Allis-Chalmers single-runner Francis turbines, with the rotating element carried on a roller bearing on top of the General Electric generators. The ultimate development will have two additional similar units.

The development comprises a structure 2000 ft. long, including 1000 ft. of spillway, 175 ft. of dam, 70 ft. of log sluice, fishway and sluice gates, 255 ft. of power house and 630 ft. of earth embankment. Choice of center line included an angle of 39 deg. 5 min. at the upper end of Island 214, which separates the spillway section from the power house.

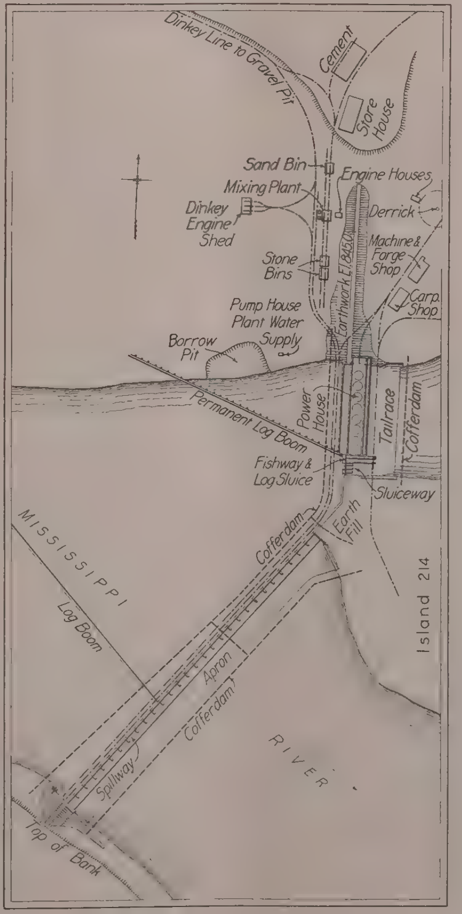
From data collected at St. Anthony Falls from 1900 to 1911, inclusive, it was determined that the head would vary from 13 to 20 ft., with an average of 17½ ft. In no sense does the dam create a storage reservoir. In fact, less energy would be obtained if storage is drawn upon than if the smaller regular flow is used under the consequent greater head. For this reason the runners of the wheels were built in accordance with one of the previously tested models, which showed an efficiency curve that dropped off slowly with increased head but rapidly with declining head.

DAM AND SPILLWAY

For the major portion of the dam a gravity spillway section is surmounted by twenty-eight Tainter gates, 33 ft. long, raising the pond level 7½ ft. over the concrete crest. It is designed to pass 80,000 sec.-ft., while 60,000 sec.-ft. are the highest discharge of record. Under the assumed maximum discharge the water will still be 7 ft. below the top of the earth embankments and 5 ft. below the top of the dam protecting the island. The Tainter gates, which are supported between piers, 3 ft. wide, will be closed under normal conditions and only opened to pass floods.

Foundation conditions under the structures require the use of piles to carry the superimposed loads, with the exception of a 400-ft. stretch at the south end, where the material was so hard that it was impossible to drive round or sheet piles. Under the power-house end of the dam hardpan, or a cemented gravel and clay, into which piles could not be driven, was 50 to 60 ft. below the river bed, rising to the surface as the opposite end of the dam was reached. Three transverse lines—140 ft. apart—of borings—100 ft. apart—were made to determine the character below ground, and test piles were driven approximately 100 ft. apart on the center line of the dam to determine the bearing value obtainable.

Conditions under the spillway section and apron are shown in one of the illustrations, in which may be noted five of the seven rows of piles under the main section. Under the upstream cutoff wall are two rows of wood piles and a row of Lackawanna-steel sheet piling. To the left in the illustration is seen the alternately laid blocks of concrete in the 2-ft. apron, which is heavily reinforced top and bottom to prevent breaking by the ice and to eliminate unequal settlement. Eight rows of piles are shown under the apron, which are cut off so as to be embedded 6 in. In addition there is a row of steel sheet piling under the cut-off wall at the downstream end of the apron. The apron is detached from the main section and drained, as shown in one of the drawings.



Plan of Coon Rapids Plant

Records of the blows toward the end of the driving operation were carefully noted and calculations made of the bearing value, 20,000 lb. per pile being allowed. A chart of pile lengths required was made up from the test piles, on which observations were made as they were driven. If the bearing value of 20,000 lb. could not be obtained, additional piles were added so as to reduce the loading per pile to a safe bearing value. Steel sheet piling was driven in maximum lengths of 25 ft. Under the dam the length was determined from the borings to penetrate the impervious material 5 to 7 ft.

As work was initiated in January, many of the piles both for cofferdam and for the foundations of the final structures were driven in a trench chopped through 3 to 7 ft. of ice, or, in the case of round piles, a stick of dynamite was exploded in a small hole. Near shore some frozen ground was encountered. Toward spring, owing to the danger of sudden thaws, the drivers usually rested on timber-capped piles. The maximum number of feet of piles driven by the five drivers equipped with 3000-lb. Warrington steam hammers was 3150 ft. per ten-hour day, while an average of 1800 ft. per day was made for five months. All wood piles were pine or tamarack.

POWER-HOUSE FOUNDATION

Excavations for the draft tubes, the lowest portion of the power house, extend 25 ft. below natural river bed through clay. The general scheme has been to drive steel sheet piling at the downstream side to hardpan and on the upstream side to drive into an overlying impervious clay.

Wooden piles, driven to sustain at least 20,000 lb. each, as under the spillway, constitute the supports. The piles under the downstream part of the power-house substructure where the greatest loads will come were driven to refusal. Maximum lengths under the power house were driven to a depth of 40 ft. and, by formula from penetration per blow, will support 22,100 lb. About 300 ft. of the steel sheet piling under the spillway section which encountered the hard strata at a higher elevation than anticipated were cut off by an oxy-acetylene torch. This work required the services of two men for six days. If time was available it was found cheaper to nick the sheet piles with a cold chisel and break off the extra portion with a side pull by a line from a pile driver. When logs from old cribs were encountered a wedge applied

Building Collapsible Scroll-Case Forms

Draft-Tube Form Assembled in Pit

to the lower end of a pile was used to cut, split or drive the obstruction to one side. Large boulders were dynamited.

DRAFT-TUBE EXCAVATION

One photograph indicates the system of bracing in the power house excavation. Braces and wales were 12 x 12-in. timbers backed by 3-in. sheeting. By the first method of sinking, the draft-tube pits, excavation and driving of sheeting progressed simultaneously, but the piles were driven after the excavation was completed. The greatest difficulty was from kicking up of the bracing due to the pushing in of the sheeting, combined with the upward thrust of the clay on the braces. Toward the end it became apparent that the timber wales could not withstand the pressures, inasmuch as at times three thicknesses of 12 x 12-in. sticks were bent almost to breaking. Finally two 15-in. I-beams were latticed together and used across the long sides of the pit as wales in five sets vertically. They were braced with three 12 x 12-in. timbers across the center of the pit between the locations of the two draft tubes. Elaborate kneebraces were also used in the corners.

By the second method of excavation, that for the three central draft tubes, the sheeting and piles were driven before any excavation was attempted. Followers were used to drive the bearing piles the full depth. Back of the draft tube the sheeting was driven successively before excavating the separate lifts. The clay was sufficiently stable to hold the lower ends of the sheeting until the wales and brace could be inserted.

Some of the bracing in the first pit was boxed in and removed after the concrete had set, but in a few instances timbers were embedded. An extension of the power house beyond the end of the draft tube was left off, as the material in front of it must be removed eventually when the concrete can be placed in much less cramped quarters.

COFFERDAMS

Cofferdams for the power house were built during the winter to enable an early start in the spring. A line of piles, driven in a diagonal direction upstream from the island above the power house, acted, with the ice inclosed, to protect the cofferdam from floating ice during the spring breakup.

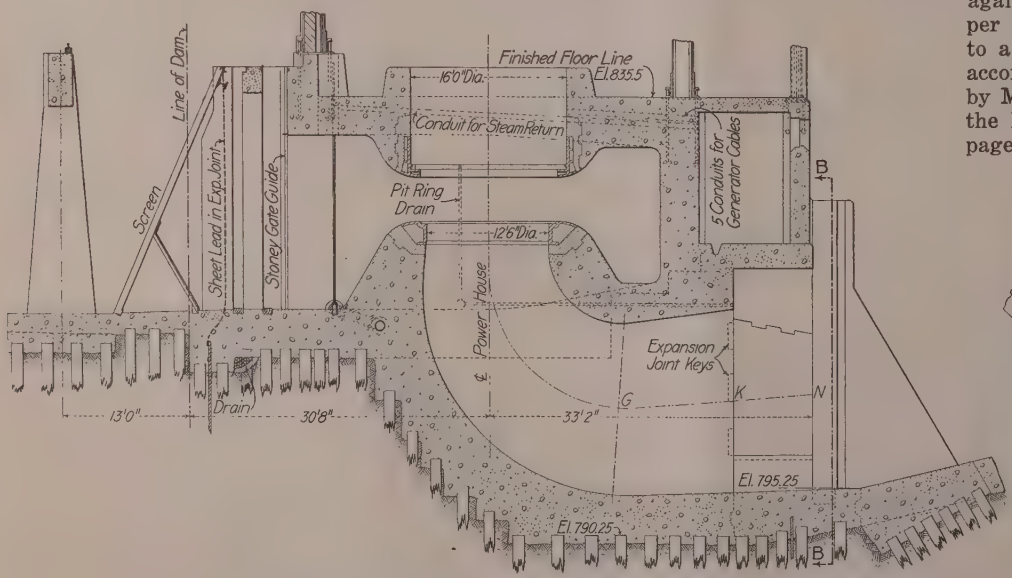
Upstream the cofferdam consists of a line of 6-in. sheeting driven into the clay and supported by two wales resting against piles driven on 7 ft. 9-in centers. These piles are braced by timbers resting against the first row of piles in the construction trestle and also against three intermediate bracing piles driven between the trestle bents.

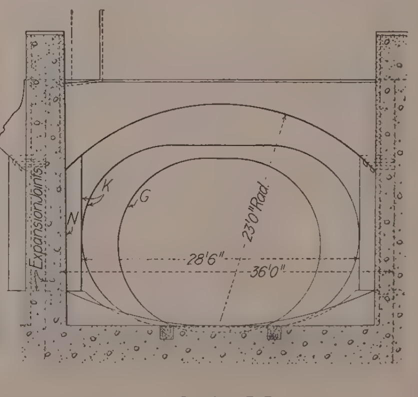
At the downstream side the same method was used, except that bracing piles were driven only opposite the main supporting piles at 7 ft. 9-in. centers. Clay was filled in on the water side and a practically bottle-tight dam was secured. The maximum water depth is 15 ft. against the dam, the top of which is 1 ft. below the highest recorded water level. Instead of the braced cofferdam noted rock-filled timber cribs with piles driven at the corners were employed in deeper and swifter water.

FORMS FOR SPILLWAY

After the spillway section of the dam, with the exception of four 54-ft. openings, and the entire apron in the first cofferdam were completed, the cofferdam was destroyed to pass the water while the remainder of the dam was being built. It is proposed to close simultaneously the four 54-ft. openings left for passing the water by means of the combined forms and cofferdam, which comprise sets of vertical and inclined steel ribs made up of two 12-in. channels and spaced on 4 ft. 2½-in centers.

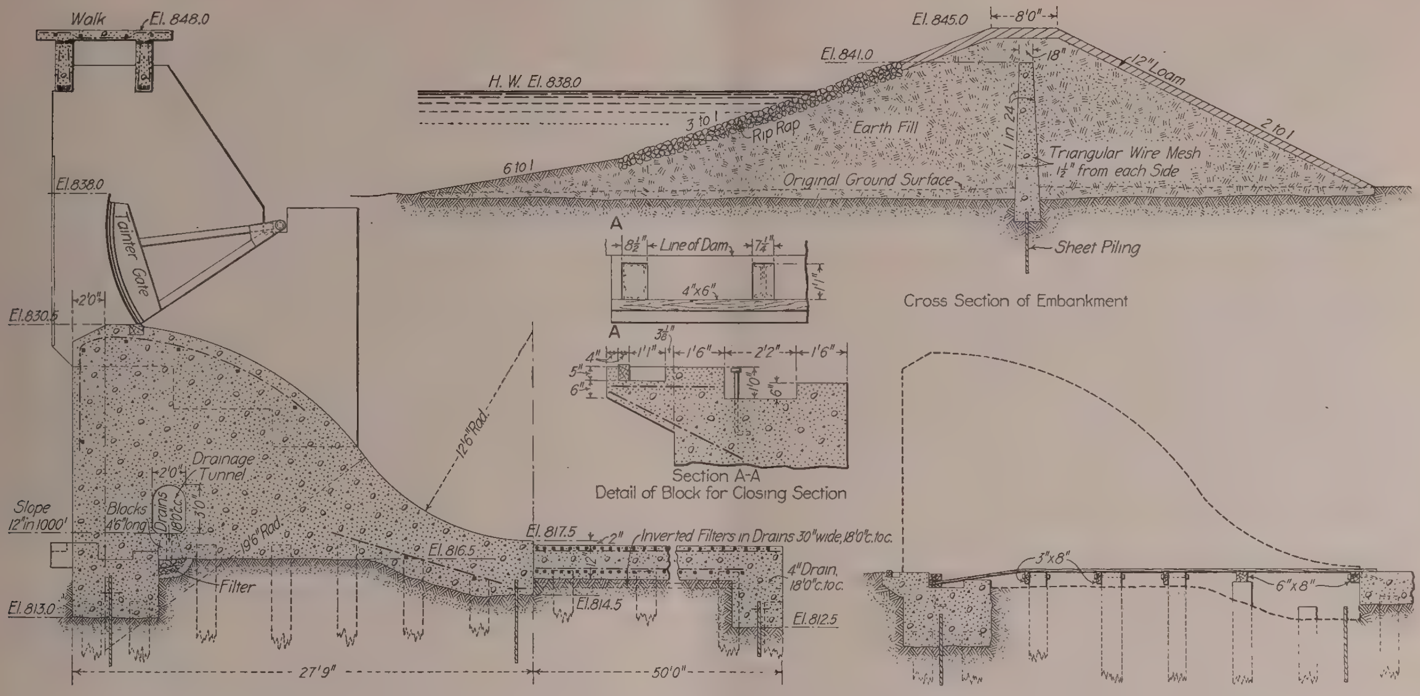
The inclined ribs are furred out to carry a pair of curved angles against which 4-in. wooden lagging is secured by clips. Rods secured to the piles hold the forms down against an assumed pressure of 1000 lb. per square foot, due to placing concrete to a depth of 4 ft. per hour. This is in accordance with experiments carried out by Major Francis R. Shunk, as reported in the Engineering Record of Jan. 15, 1910, page 71. Lagging is carried up nearly to





Section B-B

Sectional Elevation of Power House Substructure on Center Line of Main Unit and Front View of Draft Tube



Cross-Sections of Earth and Masonry Dams, with Details for Open Sections through Which River Flow Was Passed

the top of the curved portion of the dam, the remainder being finished by hand. In erecting the forms one vertical and one inclined rib are set up simultaneously and bolted together by a gusset plate attached to the top of the vertical rib. The bases of the latter fit into pockets in the concrete apron. In the design pockets were provided in concrete pedestals to receive the vertical ribs, but the idea was abandoned and the bases rest on 12 x 12-in. timbers. Two verticals at each end are latticed together for stiffness, and the remainder are spaced by bolts and pipe separators. For the closing sections, those through which water must pass during construction, a special concrete sill is deposited, as shown in one of the drawings. It provides pockets for the verticals and a longitudinal timber with which the first placed stoplog may make a tight joint. If sand accumulates in the pockets it will be removed by a jet. Over this section it was first proposed to lay concrete to a depth of 2 ft. to cap the piles, but this procedure involved an objectionable horizontal joint, so that the engineers decided to plank over the section temporarily between the upstream sill and the apron.

When used for the dam sections the inclined ribs were turned over and a trapezoidal-shaped web was used for the connection to the gusset plate on the verticals. The furring was made removable by bolting it on instead of riveting it; but it was found unnecessary to take advantage of this provision.

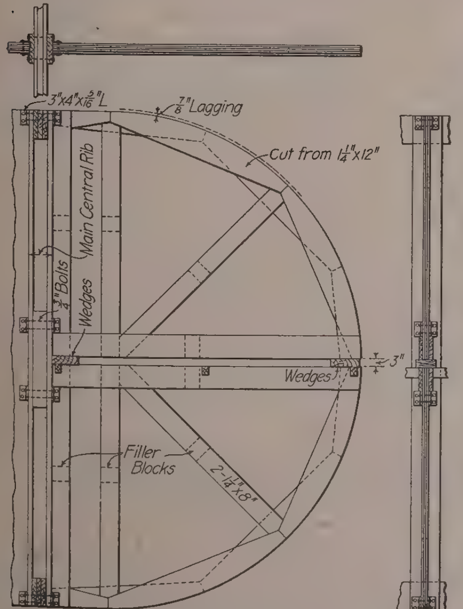
Draft-Tube and Scroll-Case Forms

Four collapsible draft-tube forms were constructed 300 ft. away from the site. Although each form contains 20,000 ft. of lumber, when it is time to set up one in the pit two days only are required to take a form apart and reassemble it in place. The form is built up on a central rib, or keel, of four sections of several thicknesses of 2-in. planks. Around the keel four sections are assembled on transverse ribs secured by short angle-iron clips. The top sections are wedged 3 in. away from the lower sections, so that they can be dropped for removal to clear the concrete. They slide out on 2 x 4-in. longitudinal struts. Each tube form is made up of sixteen quarter sections.

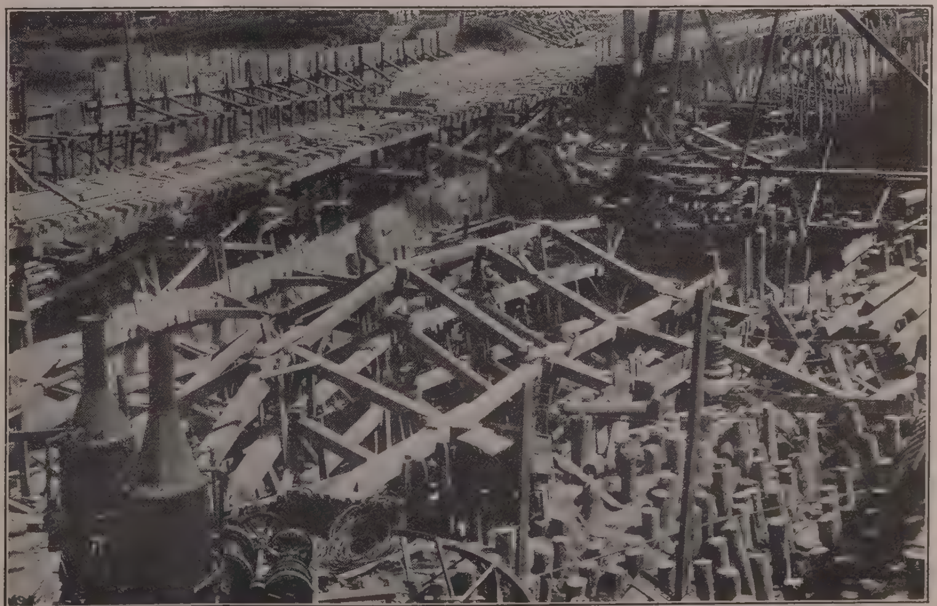
Similarly the scroll case forms are made up in sections secured to a central horizontal rib made in five sections supported on top of the uppermost draft tube section, across which a grillage of 8 x 8-in. timbers is placed to support short struts of the same dimensions. The same general scheme of wedging and removing the sections is practised as in the draft tubes.

Construction Plant

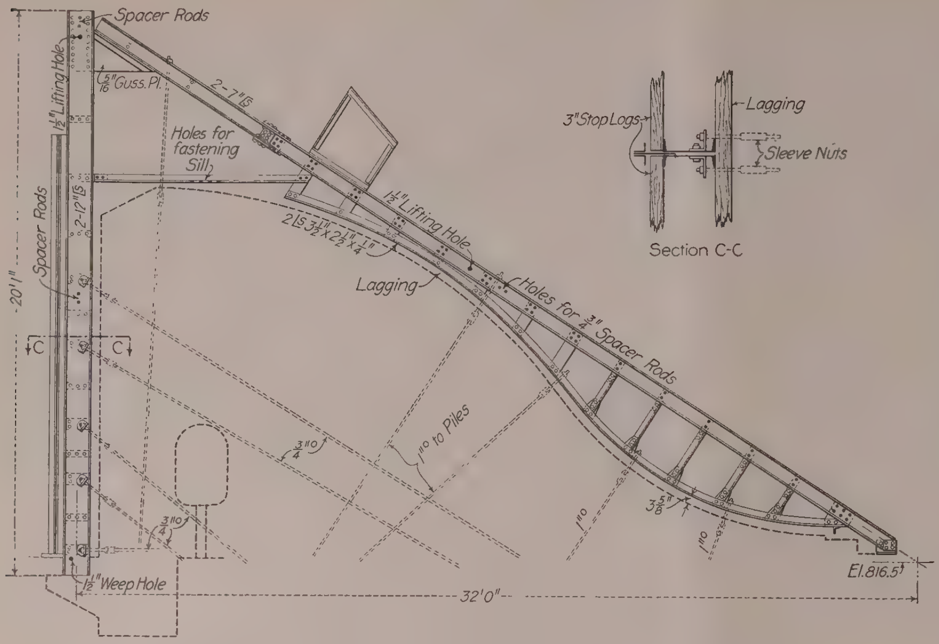
All materials are received over the Minneapolis & Northern Railway over a 4000-ft. spur which enters the plant by a high line on a trestle leading over the material bins, or by a track to the power house.



Transverse Rib for Draft-Tube Form



Bracing in Draft-Tube Excavation Distorted by Pressure



Arrangement of Steel Ribs for Forms of Spillway Section

Sand is obtained from a pit on the site, but broken stone is brought in from Minneapolis. The sand bin has a capacity of 500 cu. yd. and the broken stone storage is 1000 cu. yd. Between these bins is the mixer plant, on the main platform of which is a steam-driven hoist operating ½-yd. Peteler material cars over inclined industrial tracks from the under side of the bins to the hoppers of the two 1½-yd. motor-driven Austin cube mixers. Concrete is transported to the forms in 1½-yd. Peteler side-dump cars by four Porter dinkey engines over 3-ft. gage tracks leading past the power house to the spillway. So far 440 cu. yd. have been placed per ten-hour day as a maximum, but the usual average has been 350 cu. yd. in an equal period.

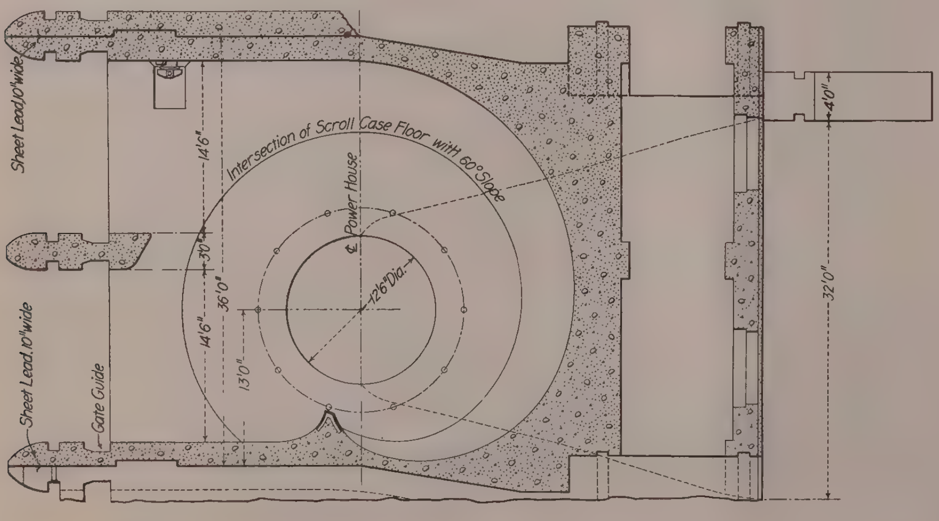
Methods of Depositing Concrete

Except where the forms are some distance from the trestle, concrete is deposited directly through rectangular chutes into the forms. Otherwise wheelbarrows or buggies are employed, a hopper being placed at the end of the chute. In cases where the concrete has been placed in forms higher than the trestle, a crane is used to raise an ordinary cylindrical bucket to an elevated chute.

Handling of material and forms is accomplished from the trestle largely by a McMyler Interstate 12-ton locomotive hoist which travels over the standard-gage track.

Camp, started in the winter, was laid out in an oak grove at the top of a 15 to 25-ft. terrace overlooking the development. The houses are built of shiplap, lined with Ford tarred roofing paper and heated with furnaces. Water from a 4-in. artesian well, 210 ft. deep, is supplied to each building and to the fire-pressure system by a Worthington two-stage motor-driven pump. Sewage is carried to a disposal system consisting of an Imhoff tank and provision for a bleach-treating process before the sewage is discharged into the river below the point of operations. During the rush period of work 900 men were housed in the camp.

The Coon Rapids development is owned by the Northern Mississippi River Power Company and leased to the Minneapolis General Electric Company. The work was designed and is being constructed by H. M. Byllesby & Company. Mr. Otto E. Osthoff was chief engineer, Mr. W. R. Thompson, manager of engineering and construction, and Mr. J. William Link, hydraulic engineer. Construction was carried on by the force-account method under Mr. W. T. Walker, construction superintendent, and and Mr. W. B. Saunders, resident engineer.



Sectional Plan of Intake and Scroll Case of Coon Rapids Development

Concrete Cribs for Pier Construction at Victoria, B. C.

Proposal to Float Them to Place over Prepared Foundation and Sink in 35 Feet of Water

TENDERS are now being invited for the construction of two piers at Victoria, B. C., which are to be followed by two more of similar size and design. The cost of the two now proposed will total $3,000,000. The piers will be 250 ft. wide, from 800 to 1000 ft. long and spaced so as to allow a 300-ft. berthing slip between them.

In preparing the foundations the first work will be the dumping of large rock at the site, bringing the water to a uniform depth of 35 ft. The maximum natural depth is 65 ft. After sufficient rock has been dumped divers are to be employed to mark off the foundation and then assist in leveling a strip 35 ft. wide just inside the entire perimeters of the docks. This leveling will be done by dumping small rubble where required and having the divers pack up the surface. The central portion of the foundation area will be left in the rough.

Concrete Cribs

While the foundation is being prepared reinforced-concrete cribs, 100 x 35 ft. in plan, with 39-ft. walls, are to be built and launched. These cribs are to be strengthened by two longitudinal walls 11 ft. 8 in. on centers and transverse bulkheads 10 ft. apart and 10 in. thick. The floors and main walls of the cribs are to be 20 in. thick, and sea cocks are to be provided in the floors to admit water for sinking the cribs after they have been floated to the exact location desired over the 35-ft. strip which has been leveled off around the foundation border. These cribs are to weigh 3220 tons each, and are calculated to draw 29 ft. of water.

The cribs will be located end-on entirely around the piers, twenty being required for pier 3, twenty-two for pier 2, and three for the bulkhead between piers. All of these bulkheads stand with their tops 4 ft. above low tide level. When the cribs have been sunk in place they are to be filled with rubble, which will then be levelled off to provide a uniform base for the superstructure. The superstructure is to be of concrete and will rise to a height of 12 ft. above the cribs for the full length of the piers. Finally, the area between the superstructural walls will be filled with hard-packed rubble.

It is estimated that 4,334 tons of reinforcing will be used in the cribs, which are to require 66,500 cu. yd. of concrete, while the superstructure will need 18,000 cu. yd. more. The total rock capacity of the cribs will be 161,000 cu. yd., while 1,094,000 cu. yd. more will be needed to fill in between the cribs and behind the bulkhead.

The plans and specifications of the docks have been prepared under the direction of the chief engineer of the Department of Public Works, Ottawa. Mr. J. S. MacLachlan, district engineer for the Dominion Government, will supervise the construction.

The Bascule Leaf of the double-track bridge across the Calumet River at Chicago was described in the Engineering Record of Dec. 20, page 607, where it was properly credited as the longest of its kind yet built. The center length, which is 235 ft., was given as 230 ft., which is the length of the next longest single-leaf bascule span—the one for the one-track Scherzer lift over the Cuyahoga River at Cleveland.

Purchasing City Supplies

Third Portion of Report by Elihu C. Church on Contracts, Prices and Quantities for Bureau of Supplies, Department of Water Supply, New York

CERTAIN phases of the reorganization of the Bureau of Supplies of the Department of Water Supply, Gas and Electricity of New York City, as outlined in a report by Elihu C. Church to Commissioner Henry M. Thompson, have been dealt with in two former articles (see Engineering Record, Jan. 3, page 21, and Jan. 10, page 52). In this, the third article of the series, the questions of contracts, prices and quantities are discussed.

The Bureau of Supplies lets all contracts for the purchase of material, and for the doing of work and the rendering of services. When the present reorganization began two years ago its share in these activities was much restricted, in fact it merely acted as agent for the other bureaus, and bought what it was told to buy, or contracted for what it was told to contract for, in a purely mechanical way.

RIGHT MATERIALS

It took much study to ascertain and formulate the fundamental principles of correct purchasing which are the answer to the first question, but once determined they proved to be quite simple. They may be concisely stated thus: Get the right materials in correct quantities at the lowest price.

The duty of always purchasing the "right" materials is the most important and difficult one that confronts the purchasing agent. The right material does not necessarily mean the best grade of stock in the market, neither does it mean the cheapest that will suffice for the purpose. The right material is the material most suitable to the purpose for which it is intended and containing the greatest units of value (service) per unit cost. A hose which might burst would be perfectly satisfactory for flushing the streets, but it would not do for fire service. One often hears the expression: "It costs a little more, but it will wear twice as long." The "wear" represents the units of service.

STANDARDIZATION OF MATERIALS

It has been one of the first and most important duties of the Bureau of Supplies to determine the various grades or qualities of materials which will be furnished for specific purposes. Multiplicity of styles and types of stock is a costly nuisance and a serious disadvantage. A list containing all the various items regularly requisitioned, and in current demand, should be prepared. These items should be considered with regard to their cost, nature, composition, wearing power, keeping qualities, and the conditions under which they are to be used. The prevailing practice at the present time consists in having the man who is going to use supplies make out an order for the quantity and quality that he wants. This order is forwarded through various officials in his bureau and is finally passed on to the Bureau of Supplies for them to make the purchase. Such procedure is all wrong.

In the first place such methods often result in men in the class of laborers being the ones who ultimately settle on the quality of materials ordered. Contrary to prevailing opinion, workmen who use materials themselves seldom order what is best suited to their conditions. They are particularly open to influence by salesmen or agents and generally order by some trade name, with very little idea of the article's real merit or those of its competitors. The careful measurements of the testing laboratory and the precise and exact experiments of the chemical laboratory should be the guide to the writer of specifications rather than the generally biased opinion of some subordinate. It is of prime importance to have all equipment of similar nature interchangeable.

Standardization of supplies permits great improvement to be made in the storekeeping system. It means less money invested in stock, less stock to be stored and looked after, and less paper work in connection with stores records, inventories and reports. The stock on hand moves faster and there is less loss from depreciation, or of stock becoming obsolete. In the absence of such standardization, there is a tendency to order the highest grade obtainable when the goods are not to be paid for by the man doing the ordering. Another tendency of men who write requisitions for which they do not pay out of their own pockets is to prepare some special design that suits their fancy rather than order standard ready-made articles. Men seem particularly prone to do this, especially if they can call on the services of a departmental carpenter to carry their plans into effect. If requisitions for unusual materials or for articles of special design can be eliminated, and standard materials for the same purpose purchased in their place, a large saving in cost can generally be effected. There are, of course, many circumstances when materials of even the highest quality are none too good, particularly so where the cost of replacement is high compared to the cost of the article; or where any failure on the part of the material in service might result in serious consequences.

The purchasing agent who deals solely with high-grade salesmen representing established business houses with jealously regarded reputations knows nothing of the trials and tribulations of the man who must receive tenders from anyone who chooses to put in a bid. One time when the bureau advertised for "boxes of matches," without stating the number each box should contain, the low bidder attempted to deliver little boxes similar to the kind cigar stores pass out with every purchase of a box of cigarettes. In another instance a man delivered feather dusters which averaged about seven feathers each and gravely contended that he was within his rights as the number of feathers had not been specified.

CONFERENCES WITH MANUFACTURERS

The ordinary salesman knows nothing of the factory conditions where his goods are produced, nor is he acquainted with the technique of production to an extent which enables him to tell how any change in specifications will affect costs. Many purchasing agents have but a clerical training, with no testing laboratory experience, and have no adequate idea of the conditions under which the goods they purchase are to be used. The salesman and the purchasing agent meet on the old ground of mutual suspicion, and discuss prices and discounts.

The most satisfactory thing to do is to get the production engineer and the factory superintendent to meet the engineer who is to use the product. The producer shows how certain customary requirements increase cost without corresponding increase in efficiency. The man using the materials tells of the difficulties he has encountered, and often finds he has not been calling for the proper material, nor using it correctly. Both sides profit from such meetings.

SPECIFYING DETAILS VERSUS CALLING FOR RESULTS

It often happens that what men desire is results and that they concern themselves but little, if at all, with the way they are produced. Specifications based on this principle state what is wanted and leave the rest to the ingenuity of the contractor. It often happens that a clever man, left to his own devices, will develop most novel and economical ways of achieving a desired result, and will be able to underbid all competitors. However, when this way is adopted, there should be no interference with the methods employed to bring about the results. Do one of two things. Either tell the contractor what you want in the way of a result, or else state in detail the way the work is to be done, and then abide by the consequences. Nothing is more unfair than to describe in detail the particular methods to be followed in doing a piece of work and then require a warranty as to the result.

It generally happens that the men who purchase supplies do not come in contact with them when in use and have no information concerning the value and the wearing qualities of the goods they buy. The closest relations should exist between the purchasing and the operating divisions.

CORRECT QUANTITY

The problem of purchasing the right quantity of supplies at a time is complex and should be governed by the following general principles:

1. There must be records showing the total quantity and nature of all stock on hand.

2. A material budget should be prepared containing the annual amount of all staple supplies used by the department. These data should be ultimately extended to give the average monthly consumption of each item.

3. The amount of material needed to meet the plans for new work, repairs, renewals, and so forth (wherever the same are to be purchased by the department), should be carefully calculated when the said undertakings are decided upon, and the supply bureau immediately informed.

THE MIDDLEMAN

Supply contracts should be so drawn that goods in different groups or divisions, as determined by manufacturing specialization or trade usage, may be bid on separately; for if orders are drawn to contain goods of different classifications the bidders will be "middlemen" and "commission merchants," not the makers of the wares nor the regular dealers in the various subdivisions in which supplies are customarily bought and sold. These “middlemen” besides adding their profits to the manufacturer’s price, thus increasing the cost of the article, are, as a rule, irresponsible parties with whom it is most unsatisfactory to do business.

Prompt Payment of Bills

Delay in paying bills does more to discredit a department with contractors, to discourage many of the best firms from competing for city business and to cause those who do bid to bid high in self defense, than almost any of the other iniquities of lax and inefficient administration. On the other hand, a reputation for fairness and promptness in meeting all obligations can only result from a carefully thought out business procedure where system rules and all work goes forward systematically without halts and delays.

Prompt payment of bills requires prompt inspections and a method of despatching which will convey these reports to the auditor in the shortest possible time so that he may pass the bills and forward them to the comptroller for payment.

Eliminating the “Hold-Up”

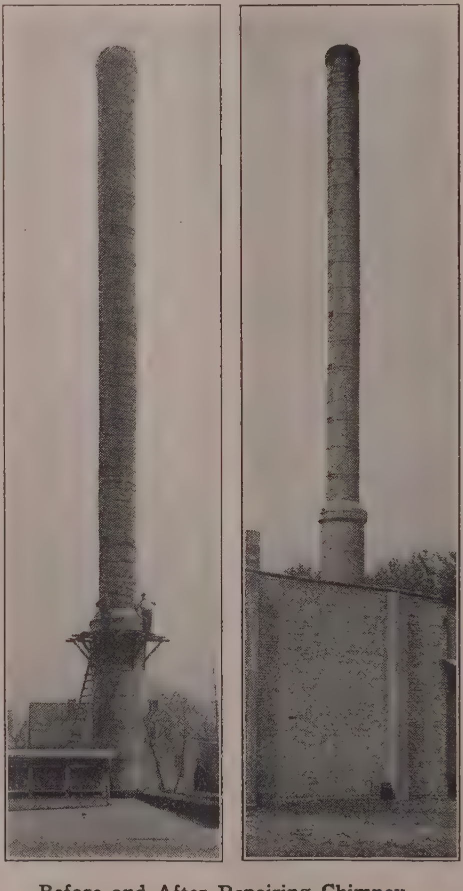
Another consideration which has been persistently worked for is to systematize all procedure so that honesty and fair dealing do not depend on the personalities of the men now in office or of those likely to come into office, but that the laws laid down for carrying on the work are such that there can be no opportunity for unfairness or discrimination toward any one doing business with the Bureau of Supplies. Witness the purchase of goods under such definite requirements that no matter who gets the order he will have to do the work properly; the elimination of adjectives and adverbs and such clauses as “work-to-be-done-in-a-suitable manner,” or “to-the-satisfaction-of-somebody-or - other,” from specifications; the publicity given to all lettings, and the notices thereof sent broadcast to all possible bidders; the immediate inspection of goods upon their delivery; the right to appeal on any rejection; the privilege of a reinspection by a different inspector when goods have been rejected; the opportunity of being present when one’s own goods or the goods of any competitor are being inspected, or analyzed and tested in the laboratory. The “pigeonhole” is the lair of graft. Any business which does not keep all matters constantly on the move, and does not have adequate records to show the progress thereof and to indicate if affairs are sidetracked, and if so by whom, is wrong in principle and in practice. When a man can “pigeonhole” papers and then wait until the people interested come along and get him to take them out again, that man—well, if he isn’t built of the right stuff, he may be subjected to temptation.

Routine Supplies and Equipment

There are certain classes of supplies of which it is necessary to purchase large quantities year after year. Under these circumstances there is a tendency to adopt a departmental design. For instance, a city determines to have its own special hydrant. Drawings are made, detailed specifications are prepared, and manufacturers requested to bid in accordance therewith. What is the result? Whereas before many independent manufacturers had bid, they now hold off, for the cost of a new pattern in accordance with the special city design must be reckoned; also, it is a bothersome matter. The firm getting the first contract has a substantial advantage in subsequent contracts, for, having the patterns on special machinery needed, they can underbid all other competitors. The city pays the difference. For this it has the advantage of the fewer spare parts needed to be kept on hand, but loses such advantage as may be obtained by getting the latest commercial article with its up-to-date improvements. Special departmental designs tend to become obsolete, and, unless the city owns its patterns and furnishes them gratis to the successful bidder, such special designs are expensive luxuries. In fact, it is a wise maxim to “let the seller design the goods.”

Repairing a Concrete Chimney

A SEVEN-YEAR-OLD reinforced-concrete chimney, 125 ft. high, was recently repaired by picking the loose material from the cracks, filling them with cement mortar, covering with two coats of waterproofing and encircling with Drolshagen ½ x 4-in. bands every 4 ft. Stress rods 1¼ in. in diameter were also placed, as shown in the photograph, from the enlarged portion at the bottom 8 ft. in diameter to a band 18 ft. above around the 6-ft. portion of the stack. The section at the bottom is 40 ft. high and the shell is 6 in. thick, while the upper portion is only 4 in. thick. Cracks began to show up shortly after construction, principally at points opposite the ring reinforcing bars. They kept increasing in size with weather action until, when repairs were made, the material easily removable down to the rods, ¼ to 1 in. inside the shell, had a maximum width of 2½ in.



Before and After Repairing Chimney

Mr. Peter Drolshagen, chimney expert, of Aurora, Ill., made the repairs for the owner, the Manz Engraving Company, of Chicago.

Exposition Hall and Bridge Shop Combined

Machinery Building at Leipzig Designed So that It May Be Converted into Industrial Plant

ONE of the principal structures for the International Building Exposition at Leipzig is the 164 x 342-ft. steel-frame building designed by Paul Banft, of Leipzig, and built by Grohmann & Frosch, and rented to the exposition for use as Machinery Hall. The building was designed with special consideration for its subsequent use by the builders as a bridge shop, and its arrangement and equipment of traveling cranes are intended to serve both purposes.

It is about 67½ ft. high to the top of the main roof and has one 85-ft. center aisle commanded by two 10-ton traveling cranes, and two 39-ft. side aisles with single 5-ton cranes. The general design of the building conforms closely to advanced steel-shop construction in this country, but the details vary considerably from it in some of the important members. The wall columns, 23 ft. apart, carry the side aisle roof trusses directly, and the center-aisle columns, 69 ft. apart, carry riveted longitudinal trusses about 14 ft. deep, each of which supports two intermediate center and side-aisle roof trusses, while every third roof truss is carried directly on the columns.

The center-aisle columns are double with two H-shape shafts 4½ ft. apart transversely, with their feet riveted between the webs of a single, long, wide, structural-steel pedestal.

The inner shaft has a much lighter section and is braced to it with horizontal and diagonal struts forming essentially the web members of a vertical truss. Riveted to the face of this column are the runway trusses, 4½ ft. deep, of the 10-ton crane girders. As these girders are thus offset nearly 5 ft. beyond the center of the main longitudinal girders, they are supported from the latter at intermediate points by cantilever brackets 23 ft. apart, which produce eccentric loading on the longitudinal trusses. The building is lighted by large continuous window areas in the side walls and in the inclined clere-story surfaces of the center-aisle roof and monitor.

An Automatic Penstock Valve at the Löntsch plant in Switzerland was, according to the “Schweizerische Bauzeitung,” put in operation through an accident on Nov. 14, 1913. Faulty operation in the power house created severe water hammer. This water hammer broke the lower end of the penstock, which is curved near the power house, and pressed the automatic emergency valve near the surge tank into service. This valve is of the butterfly type, with a vertical shaft, and is operated by water under pressure. There are three pipes in all, each provided with a set of two valves, the lower one being operated automatically and the upper valve geared for hand drive. The automatic valve closed promptly, so that the loss of water amounted only to the contents of the pipe. As the other two pipes remained uninjured, no interruption in the service took place. It is to be noted that this penstock has no air vents and, consequently, is figured to take the atmospheric pressure when emptied.

Economic Conduit Location

Diagram to Assist in Selecting Proper Type of Structure for Varying Topographical Conditions

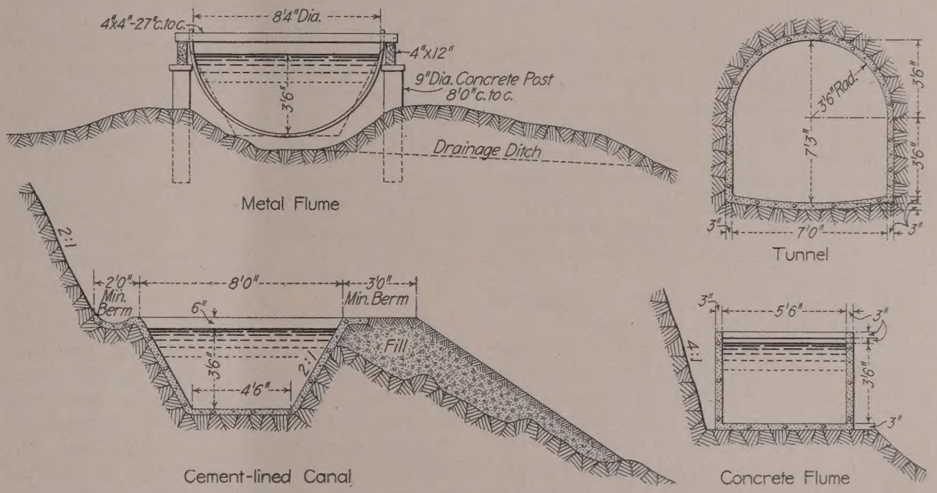
EVERY conduit carrying water, unless located in a country of uniform topography, changes at certain points from one type of construction to another for the sake of economy and safety. Rarely does a conduit of any great length consist entirely of canal section. It changes to flumes, siphons, pipes, bridge flumes or tunnels as demanded by the prevailing conditions. The points of change are determined not only by the slope of the ground, material encountered and local conditions, but also by economic considerations. In a paper printed in the "Proceedings" of the American Society of Civil Engineers for December, 1913, Mr. C. E. Hickok explains a diagram, evolved by him, giving the equivalent lengths, from an economic standpoint, of various types of conduit.

TUNNEL OR OPEN CUT?

This diagram is so constructed that when a locating engineer comes to a point where he must decide whether to tunnel through a ridge or follow the grade around it with a canal, he measures the length of the two possible routes and decides the question by means of the diagram. This not only eliminates loss of time but assures a comparison between the alternatives as to first cost, depreciation, head and evaporation and seepage loss values, interest, taxes, inspection and repairs.

Assume a case where the project under consideration is to be used for irrigation and hydroelectric purposes, and where the conduit has a capacity of 44.6 sec.-ft. and a slope of 0.1 per cent. Four types of conduit to be used are shown in the accompanying drawing.

Obviously each foot in length of conduit saved means a saving in head loss, as well as in evaporation and seepage losses. The value of this saving is ascertained in the following way, taking 1000 ft. of conduit:



Selected Types of Conduit Used for Establishing Diagram

Head Loss.—A conduit 1000 ft. long dissipates 1 ft. head. With a discharge of 44.6 sec.-ft. and 77 per cent efficiency the horsepower value is (1 x 44.6 x 62.5 x 0.77)/550 = 3.9 hp. = 2.8 kw. Subtracting 10 per cent for transmission and transformer losses, the result is 2.61 kw at $55 = $143.50.

Evaporation Loss.—Assuming an evaporation of 5 ft. per annum, (8 x 1000 x 5.0)/43560 = 0.915 acre-ft. per year = 0.0025 acre-ft. per 24 hours = 0.00125 sec.-ft. with a head of 1500 ft.; (0.00125 x 1500 x 62.5 x 0.77)/550 = 0.162 hp. = 0.121 kw. Subtracting 10 per cent for transmission and transformer losses, the result is 0.109 kw at $55 = $6.

Seepage Loss.—From tests made by Messrs. Elwood Mead and B. A. Etcheverry at the University of California it is concluded that the rate of percolation through a 3-in. canal lining under a head of 3.5 ft. is about 0.0043 ft. per hour, or 0.103 per 24 hours; (8 x 1000 x 0.103)/43560 = 0.0188 acre-ft. per 24 hours = 0.0094 sec.-ft., and (0.0094 x 1500 x 62.5 x 0.77)/550 = 1.23 hp = 0.92 kw. Subtracting 10 per cent the result is 0.828 kw at $55 = $45.54.

The total annual power loss is $143.50 + 6 + 45.54 = $195.04. This amount capitalized at 10 per cent is $1,950.40, or $1.95 per foot.

IRRIGATION LOSSES

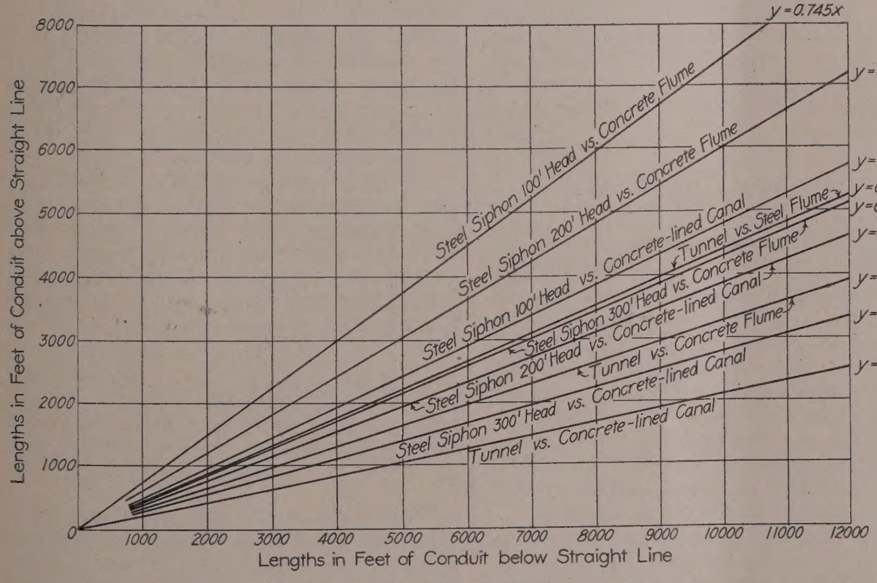
The value 0.0025 acre-ft. in 24 hours from the foregoing = 0.00125 sec.-ft. = 0.0625 miner's inch. Assume 25 per cent evaporation loss before delivery to consumer. Then 0.047 miner's inch at $0.40 per day makes $6.86 per year loss by evaporation.

The value 0.0188 acre-ft. per 24 hours, from the foregoing = 0.0094 sec.-ft. = 0.47 miner's inch. Subtracting 25 per cent loss gives 0.353 miner's inch, which at $0.40 per day makes $51.64 per year loss by seepage.

The total annual irrigation loss is $6.86 + 51.64 = $58.50. This amount capitalized at 10 per cent is $585 or $0.585 per foot.

RÉSUMÉ

The power loss per foot is $1.95; irrigation loss per foot, $0.585; total loss per foot, $2.535. The first cost and the annual charges of each type of conduit are next computed. The annual charges are taken as consisting of the following items: Interest, depreciation, taxes, inspection, and repairs. The annual charges of each conduit are capitalized at 10 per cent and added to its first cost, which gives a figure having a real comparative value. For in-



Equivalent Lengths of Various Conduits

BASED ON ESTIMATED ORIGINAL COST, ANNUAL EXPENSES AND PRODUCING VALUE OF ONE LINEAR FOOT OF CONDUIT

General Formula.— $y\,(C_y) = x\,(C_x) + (x - y)\,V + x\,(A_x) - y\,(A_y)$ where C_y = estimated cost per foot of conduit above line; A_y, estimated annual expense per foot of conduit above line capitalized at 10 per cent; C_x, estimated cost per foot of conduit below line; A_x, estimated annual expense per foot of conduit below line capitalized at 10 per cent; and V, estimated value of one foot of canal for power and irrigation purposes = $2.53. Tunnel is credited with 10 cents per foot for saving in evaporation.

Type of conduit	Values Used Original cost per ft.	 Annual expenses per ft.
Tunnel	$16.50	$1.98
Concrete-lined canal	2.30	0.325
Concrete flume	4.28	0.579
48-in. steel siphon, 100-ft. head	5.88	0.961
48-in. steel siphon, 200-ft. head	7.46	1.211
48-in. steel siphon, 300-ft. head	10.64	1.714
Steel flume	5.58	0.887

Steel siphons are credited with $1.10 per foot for saving in evaporation and seepage.
Example: 4000 ft. of concrete-lined canal can economically be replaced by less than 832 ft. of tunnel.

stance, the comparison between a lined canal and a concrete-lined tunnel is obtained as follows:

For concrete-lined canal the first cost per foot for excavation, 2 cu. yd. at $0.36, is $0.72; for concrete, 4.25 cu. ft. at $10.20 per cubic yard, the cost is $1.57. The total cost is $2.29. The annual charges are: Interest at 10 per cent, $0.23; depreciation at 2 per cent, $0.046; taxes, $0.019; inspection, $0.01; repairs, $0.02; or a total of $0.325. Capitalized at 10 per cent this makes $3.25, or together with $2.29, the first cost, a total of $5.54.

CONCRETE-LINED TUNNEL

Excavation for concrete-lined tunnel, 2.25 cu. yd. at $5.50, costs $12.40; concrete and forms cost $4.10, or a total of $16.50. The annual charges are: Interest at 10 per cent, $1.65; depreciation at 1 per cent, $0.165; taxes, $0.137; inspection, $0.01; repairs, $0.02—total, $16.50.

Capitalized at 10 per cent this makes $19.82, which, together with the first cost, gives a total of $36.32.

It is evident if the conduit is shortened by building the tunnel that the first cost and the capitalized annual cost of the tunnel can exceed the first cost and the capitalized annual cost of the canal by an amount equal to the length of conduit saved multiplied by the loss value per foot of conduit. This is shown by the equation: $Y(C_y + A_y) = X(C_x + A_x) + (x - y)\,V$ where X = linear feet of canal; Y, linear feet of tunnel; C_x, estimated cost per foot of canal; A_x estimated annual charges per foot of tunnel capitalized at 10 per cent; C_y, estimated cost per foot of tunnel; A_y, estimated annual charges per foot of tunnel capitalized at 10 per cent and V, value of losses per foot of conduit.

In the case of a tunnel, the evaporation will be considerably lessened, thereby effecting an additional saving. If entirely eliminated, this saving would amount to 12.8 cents per foot as shown above. This was reduced to 10 cents and the first cost of tunnel credited with that amount. Inserting the proper values in the equation: $Y\ (16.40 + 19.82) = X\ (2.29 + 3.25) + (x - y)\ 2.53$ or $Y = 0.208\ X$, the equation of a straight line.

In the same way any two types of conduit can be compared and the resulting straight-line equation obtained. The diagram, which is self-explanatory, shows the results.

In the case where a siphon crossing a gulch is compared with a canal or flume passing around the head of the gulch the cost of the siphon is credited with the saving in evaporation and seepage throughout its length, which in this case amounts to $1.10 per foot.

A diagram of this sort cannot be relied on entirely in the location of a conduit, for there are local conditions on every piece of work which must be taken into account.

AN IRRIGATION INVESTIGATION to determine the feasibility of the Iron Canyon project in California will be undertaken by the U. S. Reclamation Service. The project is located along the Sacramento River below the city of Red Bluff. The Reclamation Service will survey the project, prepare designs and estimate the cost. The expense incurred is not to exceed $20,000 and is to be borne equally by the Iron Canyon Project Association and the Government.

Book Reviews

A 130-page handbook, 4½ x 7 in., entitled "Yellow Pine," has recently been published by the Yellow Pine Manufacturers' Association. This is the fourth enlarged edition, the first having been issued in 1904. It is aimed to be to the lumber industry what the Carnegie and Cambria handbooks are to the steel industry. Practically all of the data are original, and portions compiled from other sources are a small part of the work. The book is bound in a flexible cover and its makeup and general appearance adhere closely to those used for the steel handbooks. Every architect, engineer, draftsman and foreman will find this book a necessity in the daily routine. It is sent free on request. (St. Louis, The Yellow Pine Manufacturers' Association.)

SHOP SKETCHING. Prepared in the Extension Division of the University of Wisconsin by Joseph W. Woolley, B.S., and Roy B. Meredith, B.S. Cloth, 6¼ x 9 in.; 102 pages; 122 illustrations. New York, McGraw-Hill Book Company, Inc. $1 net.

This book was originally prepared for use in the extension division of the University of Wisconsin. The work has necessarily and intentionally been made very elementary in character. It is intended not to make draftsmen but to teach shop men and apprentices the knowledge of drawing which they need in their work. The treatise is divided into seven chapters, as follows: 1, Principles of mechanical drawing; 2, screws and screw fastenings; 3, sections; 4, assembly and detail drawings; 5, gearing; 6, isometric drawing, and 7, free-hand drawing.

The cuts throughout the book are excellent and each new principle to be taught is well illustrated. A well-graded set of exercises is found at the close of each chapter. The work throughout is of good quality and the text is one that could well be recommended for the use of those for whom it is intended.

HANDBOOK FOR MACHINE DESIGNERS AND DRAFTSMEN. By Frederick A. Halsey, B.M.E., Editor Emeritus of "The American Machinist." Cloth, 9 x 11½ in.; 483 pages; 700 illustrations. New York, McGraw-Hill Book Company, Inc. $5 net.

This reference-data book is the product of Mr. Halsey's exceptional experience in machine design and in technical journalism. The oblivion into which many permanently useful contributions to engineering journals fade soon after publication prompted him years ago to classify articles of this type with the purpose of printing a handbook supplying the basic facts used in the design of all kinds of machinery.

The book contains, besides the groundwork of standard practice and contributions to the technical societies and press, much data supplied by specialists. The first seven pages are given over to a discussion of the mechanical principles of design, involving such fundamentals as equalized wearing surfaces and the coincidence of the center of pressure and center of a bearing. The uses of charts are also outlined.

The subjects claiming the attention of the civil engineer include ropes, chains, springs, bolts, nuts and screws, pipe, structural metals and alloys, steam boilers, steam and gas engines, compressed air and hydraulics and hydraulic machinery. Much of the description is supplied by working formulæ and tables and by sketches and diagrams, the source of information being indicated in each case. In many instances several methods are offered, the author wisely limiting himself to a comparison of the applications of these to differing conditions. In fact, the text is admirable throughout for its concise and adequate comment.

The fact that the book is of desk size, marking a departure from the pocket-book type, undoubtedly is of advantage, permitting greater detail in drawings and diagrams. Another valuable feature is the provision in the makeup for keeping the book up to date. In this plan for continuous development the co-operation of all users of the book is solicited.

Two valuable chapters are those on "Mechanics" and "Strength of Machine Parts"; the latter includes tables of bending moments, shears and deflections, safe loads, properties of I-beams and other sections, and similar data of more than ordinary interest to the civil engineer. A section on weights and measures is also included.

The handbook is completed with twenty-four mathematical tables, including the logarithmic and functional data indispensable to such a work. These exhibit the same comprehensiveness and wise arrangement that commend the volume as a whole to the engineer and mechanic.

SUSPENSION BRIDGES AND CANTILEVERS. By D. B. Steinman, C.E., Acting Dean, Professor of Civil Engineering, University of Idaho. Board, 3½ x 6 in.; 185 pages; diagrams. No. 127 Van Nostrand's Science Series. New York, D. Van Nostrand Company. 50 cents.

This book is a summary of an investigation of the relative adaptability and the economic limit of length of spans for suspension and cantilever bridges. The investigation includes the economic rise ratio for suspension bridges, the minimum depth of stiffening trusses for adequate rigidity, and the economic depth of stiffening truss. For cantilevers the economic span ratio and the minimum width are considered. Methods of designing different parts of the bridge structures are also included.

Among the principal features dealt with are the comparison of wire cables and eyebars, design of cables, towers, piers, anchorages and stiffening trusses, formulæ for weights and estimates of cost for suspension and cantilever spans and the determination of spans of equal cost.

INDUSTRIAL CHEMISTRY FOR ENGINEERING STUDENTS. By Henry K. Benson, Ph.D., Professor of Industrial Chemistry in the University of Washington. Cloth, 5 x 7½ in.; 431 pages; 52 illustrations. New York, The Macmillan Company. $1.90 net.

While based on the author's lecture notes, the book is suitable not only for students but also for a more general class of readers. It is not a book for chemists, but rather for engineers who have only an elementary knowledge of chemistry and want to become acquainted with chemical engineering methods and materials not for the sake of theory but for practical application in their engineering practice.

The first chapter describes briefly—almost too briefly—the process of transportation of materials, grinding and mixing, calcination and fusion, evaporation and distillation, filtration and separation and drying. From the standpoint of chemistry the book deals with the more common materials used in the various branches of engineering—their occurrence, mode of manufacture, properties, and, to a limited extent, uses. The author discusses in succession the atmosphere, industrial water, combustion and destructive distillation, solid fuels, liquid and gaseous fuels, petroleum and lubricating oils, pig iron, steel, alloys, clay products, hydraulic cements and lime products, paving materials and wood preservation, paint and varnish materials, plastics for electrical insulation, cellulose products and explosive materials. The book is timely and readable and should be useful.

Letters to the Editor

Bag of Sugar, Dropped, Injures Pavement

SIR: In constructing some brick pavement in Seattle recently for experimental purposes it was noticed that at one point the cement grout that was used failed to set or harden. Inquiries were made and it was found that a passenger boarding a car at this particular location dropped a 5-lb. package of sugar. Rain was falling at the time and the sugar apparently was mixed with the cement grout, the grout being applied shortly before the package was dropped. Some laboratory experiments were then conducted by placing a small amount of sugar with sand and cement of equal parts. The pat thus made up seemed to harden, but by immersing it in water disintegration immediately took place.

W. L. HOFFEDITZ,
Seattle. Inspector of Materials.

Collapse of Concrete Building at Cedar Rapids, Iowa

SIR: There is danger in certain methods of shoring a concrete-tile constructed building which I have not noted in comments upon the Stark-Lyman building failure at Cedar Rapids, Iowa. This is the method of reshoring after the original form work is taken down.

In putting up the temporary shores in a concrete building it is customary to put a cap on the top of the shore to distribute the load over a section of the floor. In some cases the men doing this shoring are not careful to get these caps under the rib in a tile and concrete construction, and I know of a case where the cap was bearing entirely on the tile. The dead load of the floors above caused the tile to crush, thus making ineffective the support at this point, which put the total dead load of the floors above on the green floor which was supposed to have been properly shored. In the case I speak of it caused this floor and one directly above it, which was being poured at the time, to collapse, but the floor below was strong enough to withstand the shock of the two floors which fell, so the damage to the building was not great.

While this may not have caused the fall at the Stark-Lyman building, it is a point which I think should be called to the attention of superintendents engaged in reinforced-concrete construction.

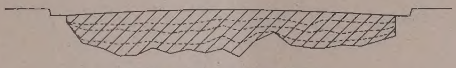
Cincinnati. W. P. ANDERSON.

Lessons from the International Road Congress

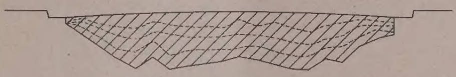
SIR: My attention has been called to an article in your issue of Oct. 11, 1913, page 405, by Col. William D. Sohier in which he gives particulars of the life of a roadway in Liverpool constructed on the pitch-macadam system. An error has been made when stating that the water-bound macadam was surfaced three times in eleven years. This should have been eleven times in eleven years.

About the year 1901 a large number of experiments were made in Liverpool with the object of improving the life of ordinary macadam stone, which in the water-bound form gave only a life of 130,000 tons per square yard, while the same stone in the form of sets laid on a concrete foundation gave a life of 10,000,000 tons per square yard.

The sample of pitch macadam which Colonel Sohier and many other American engineers saw was put down in November, 1901, and for twelve years has withstood without repair a traffic of 130,000 tons per yard width per annum, or a total of more than 1,500,000 tons. In the case of this road, therefore, the substitution of pitch macadam has increased the life twelvefold, and though this may be a favorable case it may safely be assumed from the experience of this and other roads similarly treated that a tenfold increase in the traffic life may generally be obtained.



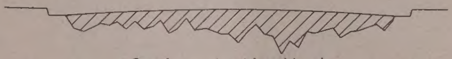
Section 12, Looking North



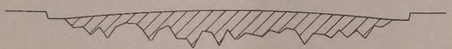
Section 8, Looking North

Pitch Macadam

Section 12 laid November, 1906. Depth of wear: 0.504 in. in four years. Section 8 laid November, 1901. Depth of wear 0.618 in. in four years. Traffic 120,000 tons per yard width per annum



Section 2, Looking North



Section 3, Looking North

Waterbound Macadam (No Tar)

Section 2: Depth of wear 0.27 in. in six months. Section 3: Depth of wear 0.248 in. in six months. Traffic 120,000 tons per yard width per annum

It might be well to point out that the binding material used is not crude gas tar but coal-tar pitch and heavy coal-tar oils heated and carefully tempered, to which is added an equal bulk of fine hot sand.

I send you herewith sections of vertical measurements on which are shown the actual wear of the surface of the macadam for a period of six months, which is the maximum time for water-bound macadam to run in this road without small repairs, and also accurate measurements over a period of four years of the piece of pitch macadam which was put down in 1901.

JOHN A. BRODIE,
City Engineer.
Liverpool, England.

Railroad Grade Crossings

SIR: Much has been said in favor of the elimination of crossings of railroads at grade. There is another side to the question, however. The average railroad of the South is altogether a different proposition from that in the congested districts of the North, where a large traffic justifies expensive construction.

The Meridian & Memphis Railway—a short line in Mississippi from Meridian to Union, a distance of 32 miles—had to cross three railroads in order to reach its terminal in Meridian. All these roads are typical of the better class of Southern railroads —single track, lightly ballasted, with comparatively good traffic. At this point only one of them has block signals. Each has continuous yard tracks extending about 2 miles out from the center of the city. In order to avoid crossing more than one track, the new road was so located as to cross each of the existing roads just beyond their respective yards, making a curve around half the city. Nearly all of this terminal line is in a level valley, affording excellent locations for industries. Grade crossings of the other railroads were therefore proposed, not only to reduce the cost of construction but, pre-eminently, to enable the new line to act as a sort of belt line for the city.

As soon as the proposed location was made known to the Mobile & Ohio, that company exposed plans for an extension of its yards still further south, with four tracks to be built at once. As this crossing was a matter of vital importance to the new road, radical steps had to be taken at once. Accordingly, condemnation proceedings were immediately instituted for crossing all three roads at grade, in the hope that with the crossings once established the other roads would necessarily have to locate their extensions elsewhere. An injunction was secured by the defendants, however, and in due course of time made permanent, sustaining their allegations that they all contemplated extensions of their yards, that they had constant use for these tracks and that the granting of the grade crossings would be confiscation of their rights. An appeal to the city of Meridian resulted in no material benefits. The matter was finally settled by the three existing railroads building bridges over their present and proposed tracks and delivering them free of cost to the Meridian & Memphis, this road building the necessary approaches therefor.

Now the point of discussion is this: Is the separation of grades always the thing to be desired? There is certainly room for argument. In this case the traffic did not justify the condemning of expensive real estate and property to get the most desirable location. There were practically no hills on which to make the ascents, and approaches had to be made on fills. Two of the roads were only ¼ mile apart and the new line had to be held up between them. From these crossings the grade makes a dip across an industrial track of the Mobile & Ohio at grade, and then ascends to go over the main line of this road.

Thus about 2 miles of the Meridian & Memphis are 25 ft. above the ordinary level, and cannot be utilized to their fullest extent in serving industries. To effect the most economical construction a mile of trestle work will be required, and it will probably be a long time before the traffic will justify a better type of construction. Derailments, which occur in unexpected places, would certainly prove most disastrous on such elevated tracks. It seems to me that these matters should be considered as against the dangers of grade crossings.

New Orleans is an exceptionally flat city. It has a public belt railroad which switches for almost every important industry in the city. Could anybody conceive of much benefit or success to be derived from this road were it to cross every other railroad overhead instead of at grade, where connections can be easily and quickly made?

Mobile, Ala. L. W. DUFFEE, C.E.

[Comment on this letter will be found in the editorial pages.—EDITOR.]

Design of Reinforced-Concrete Retaining Walls

SIR: In designing reinforcement for conditions where both bending and direct load exist, as in retaining walls of reinforced concrete, it is necessary to assume a certain amount of steel in the section and then calculate the resulting unit stresses. This is a tedious task, because the equations involved usually entail the solution of a cubic equation for the depth of the neutral axis. For special cases, usually applicable to arches only where the steel is of equal amount in both faces of the section and at depths of one-tenth the depth of the beam, access may be had to curves found in almost any text book on reinforced concrete. In the case of retaining walls, steel is usually placed only on the tension side of the section, and, as far as the author has discovered, no curves have been plotted for the various factors. As the mathematical analysis is tedious, it has been found unprofitable in practice, because the labor of making these calculations is not justified by the saving in steel over the amount needed to provide for the moment, if the direct load is ignored. There is, however, a method whereby correct results may be obtained without going through the laborious calculations mentioned above.

Assuming a linear variation in unit stress in a section we have the following conditions: First, that the unit stress in the steel divided by the ratio of the modulus of elasticity of the steel and concrete is to the extreme fiber stress in the concrete on the compressive side as the distance from the center of the steel to the neutral axis of the section is to the distance from the extreme fiber on the compressive side to the neutral axis; second, that the external bending moment, equal to the normal component of the resultant stress times the distance of this force from the neutral axis equals the moment of the total tensile and compressive stresses about the neutral axis; and, third, that the normal component of the resultant stress equals the algebraic sum of the total tensile and compressive stresses.

Expressed in equations these three conditions are

$$f_s = n\,f_c\,(d - k\,d)/d \qquad (1)$$

$$2/3\,C\,k\,d + T\,(d + k\,d) = N\,e = M \qquad (2)$$

$$C + T = N \qquad (3)$$

In which f_s = unit stress in steel; f_c, unit stress in extreme fiber of the concrete; b, width of beam (assumed 12 in.); d, depth to steel; $k\,d$, depth to neutral axis of section; n, modulus of elasticity of steel ÷ modulus of elasticity of concrete, assumed = 15; C, total compressive stress in section = $1/2\ f_c bkd$; T, total tensile stress in section = $f_s\ A_s$; A_s, area of steel in section; N, normal component of resultant of overturning force and direct load; e, distance from neutral axis to the point of application of N and M, bending moment.

After obtaining M and N from the given conditions a tentative value of $k\,d$ is assumed and C is determined and from this f_c and then f_s. Should these two latter values be satisfactory T is determined and from this A_s. If f_c and f_s are not satisfactory, $k\,d$ is varied and new values determined. After two or three variations of $k\,d$ the values of f_c and f_s can be brought within the desired values and A_s determined.

Assume an L-shaped retaining wall of the dimensions shown in Fig. 1 to retain a level fill and assume that the wall is backed up with material weighing 100 lb. per cubic foot, and having an angle of repose of 1 on 1½. Assuming a lateral coefficient as determined from Rankin's formula, the overturning moment at the base of the face wall will be

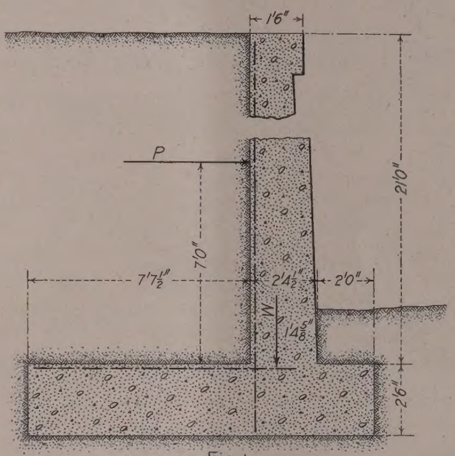


Fig. 1

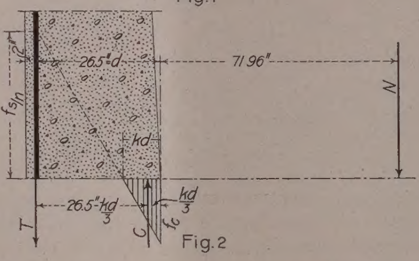


Fig. 2

$$M = 0.286 \times 100 \times (21^3/6) \times 12 = 530{,}000 \text{ in.-lb.}$$

The weight of the wall above the section assuming concrete at 150 lb. per cubic foot = 6000 lb. and its center of gravity is 16⅝ in. from the toe or 2⅛ in. inside of the center of the base. The moment of the direct load about the center of the base is M' = 6000 × (— 2⅛) = — 12,750 in.-lb.

The net overturning moment about the center of the base is 517,250 in.-lb., and the point of application of the resultant 517,250/6000 = 86.21 in. from the center of the base, or 71.96 in. from the toe as shown in Fig. 2. Taking moments about the center of the steel and assuming $k\,d$ = 9 in.

C = (98.46 × 6000) /23.5 = 25.200 lb.,

f_c = 25,200/(12 × 9½) = 466 lb per square inch, and

f_s = 466 × 15 × (17.5/9) = 13,600 lb. per square inch.

Assuming the maximum allowable unit stresses to be 650 and 16,000 lb. per square inch respectively, the above values are too low, and the amount of reinforcement excessive. Assuming kd smaller will increase these unit stresses. Let the next trial value, therefore, $k\,d$ = 8 in.

C = (98.46 × 6000)/23.83 = 24,800 lb.

f_c = 24,800/(12 × 8½) = 517 lb. per square inch, and

f_s = 517 × 15 × (18.5/8) = 17,900 lb. per square inch.

The value of f_s is too high. A value of $k\,d$ may be determined close enough by direct interpolation between the two trial values. Although the variation of stress with variation of $k\,d$ is not a linear variation, the successive values determined above for the unit stress are near enough together so that the variation can be assumed linear between them. Therefore for f_s = 16,000 lb., $k\,d$ should be varied (17,900 16,000)/(17,900 — 13,600) = 0.44 or assumed $k\,d$ = 8.5 in., then C = 24,970 lb., f_c = 490 lb. per square inch and f_s = 15,550 lb. per square inch.

This variation of f_s from 16,000 lb. is within the usual variation in spacing of reinforcement. Then

$$T = C - N = 18{,}970 \text{ lb.}$$

A_s = 18,970/15,550 = 1.22 sq. in. of steel required.

This requires 1 in. square bars spaced 10 in. on centers. Had the usual method been used the section would have been designed for a moment of 530,000 in.-lb. In this method the factor $j = 1 - 1/3\ k$ is usually assumed. Therefore assumed j = 0.9, then A_s = 530,000/(16,000 × 9 × 26.5) = 1.39 sq. in. or 1 in. square bars spaced 8½ in. on centers.

$$p = A_s/b\,d = 0.0044$$

and

$$k = \sqrt{2\,p\,n \times (p\,n)^2} - p\,n = 0.303 \text{ or}$$
$$j = 0.899.$$

This value of j is practically as assumed above. The saving of steel effected is therefore (10 — 8½)/10 = 15 per cent, which is worth while when no more work is involved than above. In some cases the position of the center of gravity of the wall will cause a larger negative moment about the center of the base, in comparison with the overturning moment, to be developed than in the above case, and in such cases the reduction in steel required would be still larger. As the height of the wall and likewise the direct load increases this saving is also more noticeable.

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HIGHWAYS IN WASHINGTON STATE was the subject of a paper read at the North Yakima good-roads convention by Mr. W. J. Roberts, retiring State highway commissioner, who said that the State of Washington is now spending more than $5,000,000 per year on highways, exclusive of bond issues. The State highway commission, he said, expended $348,000 last year on State roads, will award $149,000 worth of contracts at an early date and has plans completed for further work to cost about $116,000. At the present time the State of Washington, with an area of 69,000 sq. miles, has 40,000 miles of roads.